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** PBDAT200 **

A COMPUTER PROGRAM FOR PROCESSING RAW Pb-U-Th ISOTOPE DATA

by

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TABLE OF CONTENTS

SUBJECT	PAGE
Introduction	1
Hardware Required	2
Getting Started	2
Entering Data from the Keyboard	4
Introduction to **FORM** screens	4
The "WEIGHTS" **FORM** for Pb-208 spiked samples	6
Sample weight	6
Total aliquot weight	6
Pb-unspiked aliquot (grams)	6
Pb-spiked aliquot (grams)	6
U/Th-spiked in total (1) or Pb-spkd (2) aliq	6
Pb-spike (U-spike, Th-spike) delivered	6
The "Pb-unspiked ratios" **FORM** (Pb-208 spkd samples)	7
The "Pb-spiked ratios" **FORM** (Pb-208 spkd samples)	7
The "U-spiked ratios" **FORM** (U-235 spkd samples)	8
The "Initial-Pb isotope ratos" **FORM**	9
Samples spiked with a mixed U-233/U-236/Th-230 spike	10
Samples spiked with a mixed Pb-205/U/Th-230 spike	12
Entering data for blanks	12
Entering Data from **VISICALC**-Created Raw-Data Files	13
Using embedded specifiers with raw-data spreadsheets	15
Storing **VISICALC** raw-data files	16
Reducing data from a **VISICALC** raw-data file	16
Using **LABDATA** Files	20
Defining a new **LABDATA** file	20
Other **LABDATA** file operations	21
References	22
Figure Captions	23
Figures	24-31
Appendix: Program List of **PBDAT200**	32

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INTRODUCTION

PBDAT200 is a version of a family of Pb-isotope data-reduction programs that were first written for HP-9830/9831 computers (Ludwig, 1982a). The most recent precursor (Ludwig, 1984) is a program written for HP-86/87 computers. These programs suffered from both a lack of computational speed and a requirement that the user be familiar enough with the philosophy of the programs to always do everything "right". But with the current availability of inexpensive microcomputers with very large amounts of memory, a very fast microprocessor, and a highly structured BASIC language, it has been possible to rewrite these programs into one that is much more flexible, rapid, and tolerant of operator errors or misunderstanding: **PBDAT200**.

PBDAT200 takes raw Pb-U-Th isotope data (either typed in from the keyboard or from **VISICALC** files), including all relevant data from the chemistry laboratory, and calculates elemental and isotopic concentrations, isotope ratios, apparent ages, uncertainties and error-correlations in these values using the algorithms developed in Ludwig (1980). The resulting data (figure 1) is corrected for instrumental mass fractionation, for laboratory blanks, and for the initial Pb of radiogenic samples. Data defining the particular spikes and blanks of a particular laboratory are entered by each user, and stored as user-specific data files on the same disk as the **PBDAT200** itself. Because of this feature, several different laboratories can use the same program without the need for program modification.

Raw data that has been stored as a **VISICALC** file can be converted (either in whole or in part) to a reduced-data file which is compatible with the **ISOPLOT200** plotting program (Ludwig, 1985b). **PBDAT200** can accept data from laboratories using a variety of spikes, including ^{208}Pb, ^{206}Pb, ^{205}Pb, ^{235}U, ^{233}U-^{236}U, and ^{230}Th. These spikes can be delivered either by liquid aliquot or to the total sample, for any combination of elements. Keyboard data-input is managed by a flexible, friendly, and error-resistant **FORM** screen which makes extensive use of **HELP** screens and error-trapping.

HARDWARE REQUIRED

PBDAT200 requires a Hewlett-Packard SERIES 200 computer running under BASIC 2.1 or BASIC 3.0, with at least 256 kbytes of memory over that required for the BASIC operating system. If the BASIC 2.1 operating system is used, the AP2_1 binary must have been loaded before running the program. For BASIC 3.0, the following binaries must also be resident in memory: MAT, KBD, ERR, KNB2_0, CS80, DISC, HPIB, and MS.

The program assumes that the printer is connected to the HPIB interface at address 701, and that a dual-disk drive is present at address 700. To make use of the data file features of **PBDAT200**, you'll need the **VISICALC** program to be able to create the raw-data files.

GETTING STARTED

Put the disk containing the **PBDAT200** program in the default disk drive (the BASIC operating system must already be in memory) and type **LOAD "PBDAT",1**. Press the **EXECUTE** key. The program will take about a minute to load, then the CRT will display,

```
**********************************************************************
FILES PRESENT ON THE DISK IN DRIVE 0:        LABEL:  B9826

JOHNS_LAB    OLDLAB    NEWLAB    BLD615LAB    JMF    GALENALAB

**********************************************************************

YOU MUST HAVE A LABDATA FILE IN MEMORY TO PROCEED.

SELECT A LABDATA FILE WITH ARROW KEYS, THEN PRESS EXECUTE

(Press k4 to define a new LABDATA file,
 press k0 or k1 to change the LABDATA disk drive)
```

DRIVE 0	DRIVE 1			DEFINE NEW
				ESCAPE

In order to use **PBDAT200**, you'll need to either select an existing **LABDATA** file, or create a new one. For now, just select one of the existing files so you can see how the program works; I'll go over **LABDATA** files in detail in a later section. To select a **LABDATA** file, use the left- and right-arrow keys to change which **LABDATA** file is highlighted; when the one you want to use is highlighted, press the **EXECUTE** key. The **LABDATA** file will be accessed, and the CRT will display:

Note the highlighted boxes at the bottom of the CRT. The words in these boxes tell you what the current functions of the softkeys are (the 10 keys labelled **k0** through **k9** at the upper left of the keyboard), and "map" directly to them. So the word in the upper-right box corresponds to the upper-right softkey (**k0**), the lower-right box to the lower-right softkey (**k9**), and so on.

PBDAT **rev. July 24, 1985** **K.R. Ludwig, U.S. Geol. Survey**

LABDATA file is ZIRCONLAB

PRESS k9 TO ENTER RAW DATA FROM THE KEYBOARD

PRESS k4 TO ENTER RAW DATA FROM A DATAFILE

PRESS CTRL I TO LOAD & RUN ISOPLOT

SPIKED WITH Pb-208 AND U-235 **CRT IS OUTPUT DEVICE**

CHANGE Pb0	Pb208 SPIKED	U-235 SPIKED	LABDATA	DATAFILE
USE PRINTER	Pb205 SPIKED	U-233 SPIKED	HELP	KEYBOARD

I'll refer to the above display as the Top-Level Screen. Look at the message in the lower-right corner of the CRT (CRT IS OUTPUT DEVICE). This tells you that all output will appear only on the CRT. If you want your reduced data to be printed out on the printer, press softkey **k5** (USE PRINTER). Notice that the message in the lower-right corner changed to reflect your request, and that the definition of softkey **k5** is now USE CRT. In general, the softkey definitions indicate what the softkeys will do when pressed, not what the current status of that function is.

The phrase at the lower-left of the CRT tells you which type of spikes the program assumes are being used (Pb-208 or Pb-205, U-235 or U-233/236). If the phrase isn't correct for your samples, just press the appropriate softkey to change the assumed spikes.

Notice that softkey **k8** is labelled **HELP**. **HELP** softkeys exist in several parts of the program, and when pressed will display information on the CRT that will help you figure out what to do (how to answer queries, more detailed explanations of the softkey-functions...). For your first sessions with the program, you should invoke every **HELP** screen available to become more familiar with the general philosophy and terminology of the program.

ENTERING DATA FROM THE KEYBOARD

INTRODUCTION TO FORM SCREENS:

First, press the **Pb-208 SPIKED** and **U-235 SPIKED** softkeys to use for our example. Press the **KEYBOARD** key to start keyboard data-entry. The CRT will then display:

```
SAMPLE NAME ------------------------) ??

SAMPLE WEIGHT (grams)                  1
TOTAL-ALIQUOT WEIGHT (grams)
    (enter only if appropriate)        --
Pb-UNSPIKED ALIQUOT (grams)            0
Pb-SPIKED ALIQUOT (grams)              1
U/Th SPIKED IN TOTAL (1)
       OR Pb-SPIKED (2) ALIQUOT        2

Pb-SPIKE DELIVERED (grams)             0
U-SPIKE DELIVERED  (grams)             0
Th-SPIKE DELIVERED (grams)             0
```

Use ARROWS, (CTRL) CONTINUE, or KNOB to move cursor

ENTER a new value, press EXECUTE when all parameters are defined.

				HELP
				ESCAPE

This is a **FORM** screen -- a format for data-entry used extensively by **PBDAT200**. Notice that the top line (SAMPLE NAME) has a row of dashes (the **FORM** cursor) extending to a pair of question-marks, and that the question-marks are highlighted. The dashes and highlighting indicate that SAMPLE NAME is the parameter that the **FORM** cursor is on. Type in a name for the sample whose data you are entering. The double-question marks will disappear, and your sample name will appear in its place as you type it in. Press the **ENTER** key when you've finished typing in the sample name, and the **FORM** cursor will move down to the next parameter with the sample name remaining where you typed it. You can move the **FORM** cursor to any parameter by pressing the up-arrow or down-arrow keys, by pressing the **CONTINUE** (next parameter down) or **CTRL-CONTINUE** (next parameter up) keys, or by rotating the KNOB at the upper-left of the keyboard.

To enter a value for a parameter, move the cursor to the appropriate parameter and type in the value. You can edit what you type in with the left- and right-arrow keys, the **DEL CHR**, **INS CHR**, **BACKSPACE**, and **CLR LN** keys. When you're satisfied with what you've typed in, press the **ENTER** key and the value will be entered for that parameter. If you've made an obvious error, the computer will display an error message at the bottom of the CRT and ask you to re-enter the value. Notice that even if you type something into one of the response areas, unless you press the **ENTER** key it will disappear when you move the cursor to another parameter.

When you've entered values for all the required parameters (a double question-mark in a response area indicates that you must enter a response for that parameter; other parameters may be optional), submit the form by pressing the **EXECUTE** key. Until you do this, none of the values that you entered will be used. If you want to escape from the **FORM** at any time, just press the **ESCAPE** softkey. When you press the **ESCAPE** softkey, none of the values in the **FORM** that you enter will be retained by the program.

Softkey **k4** is defined as a **HELP** key for the **FORM**s. If you don't understand the significance of a parameter in the **FORM**, put the **FORM** cursor on that parameter and press the **HELP** softkey. The CRT will then give you more information on what the significance of that parameter is and what sort of response is required.

A handy feature of the data-input **FORM**s is that you can reuse the last values entered for any **FORM** by pressing the **RECALL** key when the **FORM** is displayed. The last-entered values for that **FORM** will then appear in the current **FORM**. This feature is especially useful if you made an error in entering the data for a sample but didn't notice the error until after you submitted the **FORM**.

THE "WEIGHTS" FORM FOR ^{208}Pb-SPIKED SAMPLES

The above **FORM** requires values for the various weights involved in a sample analysis. Their significance is as follows:

Sample Weight:

The weight of the sample that was actually attacked and put into solution, in grams.

Total Aliquot Weight:

The weight of the total solution of the entire sample, in grams. Enter a value here if you only extracted a fraction of the total solution of the sample; if all of the solution was used (so that the Total Aliquot is just the sum of the Unspiked Aliquot plus Spiked Aliquot weights), you needn't enter any value here - it will be assumed to be the sum of the weights of the spiked and unspiked aliquots.

Pb-Unspiked Aliquot (grams):

The weight of the solution used as the Pb-unspiked aliquot. Samples spiked with Pb before dissolution will have no Pb-unspiked aliquot, nor will blanks. In these cases, the Pb-unspiked aliquot weight is zero.

Pb-Spiked Aliquot (grams):

The weight of the solution spiked with ^{208}Pb.

U/Th-Spiked in Total (1) or Pb-spiked (2) Aliquot:

If the sample were total-spiked (spiked before attack or before any aliquoting) for U(Th), enter a value of **1**. If the U(Th) spike were added to the same aliquot as the Pb-208 spike, though, enter a value of **2**. Incidentally, **PBDAT200** always assumes that if a Th-230 spike were used, it was either mixed with the U spike or added to the same aliquot as the U spike.

Pb-Spike (U-Spike, Th-Spike) Delivered (grams):

The amount of the Pb, U, or Th spikes delivered, in grams. If the Th spike is part of a mixed U-Th spike, then the U and Th spike weights must be the same.

THE "Pb-UNSPIKED RATIOS" FORM (^{208}Pb-SPIKED SAMPLES):

After you submit the completed WEIGHTS FORM, the next FORM will be:

Pb-UNSPIKED ALIQUOT:

206/204 ----------)	??
%error	??
206/207	??
%error	??
206/208	??
%error	
Pb-BLANK (nanograms)	??

(ERRORS MUST BE 2-SIGMA)

Enter values for the three ratios, together with their errors. The ratios should be uncorrected for mass fractionation, and the errors should be at the 2-sigma (or 95%-confidence limit) level, in percent. The errors should correspond to the statistical errors from the mass-spectrometer run, without including the uncertainty due to mass-fractionation.

If you entered a value of zero for the Pb-unspiked aliquot weight in the previous FORM, the above FORM will ask you only for the estimated Pb-unspiked 206/208 ratio. You may not have any hard data for this ratio, but you'll still have to enter an estimate in order to get any reduced Pb-data.

The Pb blank is the blank that corresponds to the unspiked portion of the analysis only. So if the dissolution process alone contributed a significant amount to the overall blank, you should include only that fraction of the dissolution blank that corresponds to the Pb-unspiked aliquot.

If you didn't measure Pb-isotope ratios for the Pb-unspiked aliquot, just bypass this FORM by pressing the ESCAPE softkey.

THE "Pb-SPIKED RATIOS" FORM (^{208}Pb-SPIKED SAMPLES):

The next FORM requires the Pb-isotope ratios for the Pb-spiked aliquot, as shown below:

Pb-SPIKED ALIQUOT:

206/204	**(enter if known)**
%error	**?**
206/207 ----------)	**(enter if known)**
%error	**?**
206/208	**??**
%error	**??**

The 206/204 and 206/207 ratios for the Pb-spiked aliquot are optional -- if you don't have data for one or both of these ratios, don't enter any values for them. If your sample contains radiogenic Pb, though, you should always include the 206/207 ratio for the Pb-spiked aliquot, because **PBDAT200** can calculate the Pb concentration more accurately if it is included.

If there were no Pb-unspiked aliquot ratios, the Pb-spiked aliquot **FORM** will also ask for the estimated Pb blank. Enter the Pb blank that corresponds to the Pb-spiked aliquot.

THE "U-SPIKED RATIOS" FORM (^{235}U-SPIKED SAMPLES):

The next **FORM** requires the U and (optional) Th isotope ratios of the spiked aliquot and their estimated blanks, as shown below:

U-SPIKED ALIQUOT:

238/235 ----------)	**?**
%error	**?**
232/230	**?**
%error	**?**
U- BLANK (nanograms)	**?**
Th-BLANK (nanograms)	**?**

Enter the ratios and uncertainties as before. The blank assignments should reflect only the blank for the U(Th)-spiked aliquot. You can enter zero if you feel that the blank is negligible. If the sample wasn't spiked for U or Th, or if you didn't measure any U or Th isotope ratios, just press the **ESCAPE** softkey.

THE "INITIAL-Pb ISOTOPE RATIOS" FORM:

If the Pb in the sample is radiogenic and you want to calculate Pb-U-Th isotope apparent ages, you must enter estimated values for the initial-Pb isotope ratios in this **FORM**. If the Pb in your sample is nonradiogenic (common), or you aren't interested in apparent ages, just **ESCAPE** from this **FORM**. The initial Pb is defined as the Pb which was present at the time the U-Pb system of interest was "born". For a mineral or rock, this will generally be the Pb present at the time of formation of the mineral or rock.

The **FORM** for the Initial-Pb ratios is shown below:

INITIAL-Pb ISOTOPE RATIOS:
(Errors are absolute, not %)

206/204 ----------)	**18.70**
error	**0**
207/204	**15.63**
error	**0**
208/204	**38.63**
error	**0**
206/204 - 207/204 error-correlation	**0.9**
(Stacey-Kramers Model-Age?)	**?**

The default values are those for a zero-age system on the Stacey-Kramers Pb-growth curve (Stacey and Kramers, 1975). The errors for the ratios must be entered at the 2-sigma level and in absolute values, not percent values. Enter nonzero errors only if you have reason to believe that the actual initial-Pb isotopic composition was different from sample to sample, or if this is not one of two or more samples in a suite. If you're reducing data for several cogenetic samples and you intend to pool the data for a concordia-diagram treatment, enter zero errors even though there is some uncertainty in your estimates of the initial-Pb ratios.

If you do enter nonzero errors for the initial-Pb ratios, you'll need to enter an estimate of the correlation between the 206/204 and 207/204 errors. This value should always be nonzero - typically in the range of 0.8 to 0.95. This error correlation value is the same as the conventional correlation coefficient that you'd get if you did a linear regression of the 207/204 versus 206/204 for several samples representing the true range of initial-Pb ratios for the system from which your samples were derived. If none of this makes much sense but you still need to enter nonzero errors, try an error correlation of 0.9

You can have **PBDAT200** use the Stacey-Kramers growth-curve values (Stacey and Kramers, 1975) for any age by typing in the age as the last parameter (Stacey-Kramers Model-Age), then pressing the **EXECUTE** key. The Pb-isotope ratios defined by the Stacey-Kramers curve for that age will immediately appear in the **FORM**, after which you can either edit the values, or just press the **EXECUTE** key a second time to submit the filled-out **FORM**.

SAMPLES SPIKED WITH A MIXED ^{233}U-^{236}U (-^{230}Th) SPIKE:

For samples spiked with a mixed ^{233}U-^{236}U spike instead of a ^{235}U spike, **PBDAT200** accepts two different types of data input. The first type is for data that is already partially reduced so that the Sample-238/Spike-233 ratio has already been calculated. This should be the case for data from a mass spectrometer running under either **ANALYST** (Ludwig, 1985a) or **DBAT2B** (Ludwig, 1982b). The Sample-238/Spike-233 ratio is simply the ratio of moles of natural ^{238}U in the U-spiked aliquot to the moles of ^{233}U delivered as the spike. The second type is for raw $^{233}U/^{236}U$ and $^{233}U/^{238}U$ ratios.

The default type of data-input for ^{233}U-^{236}U spiked samples is the first one (Sample-238/Spike-233). To change from the default type, press **SHIFT k7** (labelled **U233 SPIKED**) from the Top-Level **PBDAT200** display. You can then choose either of the two data-input formats.

For the first type of data input, the **FORM** screen will look like:

U-SPIKED ALIQUOT:

SAMPLE-238/SPIKE-233 -------) ?
%error ?

232/230 ?
%error ?

U- BLANK (nanograms) ?
Th-BLANK (nanograms) ?

Enter the calculated ratio of the moles of ^{238}U in the U-spiked aliquot of the sample to the moles of ^{233}U that you added from the spike. The rest of the FORM is the same as for ^{235}U-spiked samples.

The second type of 233/236/238 FORM (Sample-238/Spike-233 not calculated) will look like:

U-SPIKED ALIQUOT:

233/236 ----------) ?
%error ?

233/238 ?
%error ?

232/230 ?
%error ?

U- BLANK (nanograms) ?
Th-BLANK (nanograms) ?

Just enter the raw (uncorrected for fractionation) ratios and errors as usual.

SAMPLES SPIKED WITH A MIXED ^{205}Pb-U-^{230}Th SPIKE:

For samples that were total-spiked with a mixed ^{205}Pb-U-^{230}Th spike (the U can be either 235 or 233-236), the first **FORM** will be:

Pb-205 SPIKED SAMPLE:

SAMPLE NAME ----------) ??

SAMPLE WEIGHT (grams) ??

Pb-205 SPIKE DELIVERED (grams) ??

This **FORM** assumes that the ^{205}Pb spike was delivered to the total sample represented by the sample weight.

The next **FORM** for a ^{205}Pb-spiked sample is:

Pb-SPIKED ALIQUOT:

206/204 ----------) ??
%error ??

206/207 ??
%error ??

206/208 ??
%error ??

206/205 ??
%error ??

Pb-BLANK (nanograms) ??

The Pb blank is the blank that corresponds to the complete attack, extraction (if any), and loading procedure. The rest of the data input (for ^{205}Pb-U-Th spiked samples) is the same as for ^{208}Pb-spiked samples.

ENTERING DATA FOR BLANKS:

For Pb-blanks, you usually won't have any specific data for the Pb-unspiked aliquot ratios, and you might not have any data for the Pb-spiked 206/204 ratio. So for blanks, enter the weight of the Pb-unspiked aliquot as <u>zero</u> (since there wasn't any un-

spiked aliquot). **PBDAT200** will still ask you for an estimated value for the unspiked 206/208 ratio, however. Enter your best guess for this value - unless your blank is very underspiked, your guess doesn't have to be too accurate. You'll also need to enter an uncertainty in your estimate -- 5% isn't too large if you know only that the blank Pb is a "normal" common Pb.

The Pb-BLANK value that you enter into the Pb-Spiked Aliquot Ratios **FORM** will depend on what type of blank-determination you are doing. For a total-blank, enter a blank-value of zero. For a reagent blank, though, you should enter the estimated blank for loading plus whatever handling (evaporation, weighing...) accompanied the blank procedure.

ENTERING DATA FROM VISICALC-CREATED RAW-DATA FILES

The best method for reducing data for more than one or two samples at a time is to put the raw data in a **VISICALC** spreadsheet, so that you can edit the raw data at any time or re-reduce some of the data with new **LABDATA** file values without having to retype in a lot of data. You'll need the **VISICALC** program, of course.

To be compatible with **PBDAT200**, the format of your raw-data **VISICALC** files must conform to certain criteria. These criteria are:

1) the column-width must be 9 characters (the default setting);

2) the first 2 columns (A and B) must contain the sample names, as well as any embedded specifiers (see below);

3) the data in each column must conform to the column-headings as shown in figures 2 and 3;

4) the column-headings must directly overlie a row consisting of repeating equals-signs that extends over exactly as many columns as are in use for the raw data.

5) the first row can contain a file title of up to 80 characters.

If you use the TEMPLATE file (on the same disk as **PBDAT200**) to start your raw-data spreadsheets, you won't have to worry about getting the format right. Just bring up the **VISICALC** program (read the documentation for the program if you don't know how to do this), and load in the TEMPLATE file with the **/SS** command. You'll have to specify the volume label from **VISICALC** to access the TEMPLATE file; it's probably B9826 if the disk was initialized from the BASIC operating system. If not, check the label with the CAT command from BASIC.

The TEMPLATE spreadsheet contains the appropriate column-headings for both Pb-208 spiked samples and Pb-205 spiked samples, as well as U-235 or U-233/236 spiked samples. If the spreadsheet will contain data for Pb-208 spiked samples, delete the rows containing the column-headings for Pb-205 spiked samples; do the opposite if your samples will be spiked with Pb-205, and also delete the extra columns. The column-headings for the two types of samples are shown in figure 3, and a sample raw-data spreadsheet is shown in figure 4.

Note that the first 2 columns (A and B) contain the sample names. You can include more information on the samples by using the rows above or below the row that contains the numeric data for the sample. Just make sure that no numeric data appears to the right of these additional comments.

If you don't have any data for one of the columns, or if that column is irrelevant (for example, thorium data when you didn't spike the sample for thorium), don't enter anything in that column. You can use the **REPLICATE** command (**/R**) to fill in several cells in a column with the same value (such as blanks). Enter all errors (uncertainties) at the 2-sigma level and in percent.

Note that the columns for uranium isotope ratios and errors can contain either the 238/235 ratio and error, the Sample-238/Spike-233 ratio and error, or the 233/238 ratio and error. The program will assume one or the other depending on whether (1) the sample were spiked with a Pb-205 mixed spike, in which case the **LABDATA** file will specify a 235 or 233/236 U-spike, (2) you specified a U-235 or U-233/236 spike from the Top-Level CRT display, (3) which data-input format for U-233/U-236 spiked samples you are using, and (4) you have embedded specifiers (see below) within the sample name columns of the raw-data spreadsheet.

If your data is for ^{233}U-^{236}U spiked samples with raw 233/236 and 233/238 ratios, the 233/236 ratios and errors must occupy the last two columns of the spreadsheet (**AC** and **AD** for 208-spiked samples, **T** and **U** for Pb-205 spiked samples).

USING EMBEDDED SPECIFIERS WITHIN THE RAW-DATA SPREADSHEET:

The raw-data spreadsheet can contain all of the necessary information to tell the program how the data is to be reduced, including which **LABDATA** file to use, whether spiked with Pb-208 or Pb-205, U-235 or U-233/236, and whether the U-Th was spiked in the total aliquot or the Pb-spiked aliquot. These specifiers can change from sample to sample, so that a large raw-data spreadsheet can contain data reduced at various times (or by various laboratories), with different spikes and procedures, yet the whole file can be reduced in a single request that creates a single reduced-data file.

Embedded specifiers consist of a few characters enclosed in asterisks, and must occur within the sample name columns (A and B). The specifiers affect how data for samples <u>below</u> the specifiers are reduced. The types of embedded specifiers that you can use are shown below:

SPECIFIER	SIGNIFICANCE
L	The characters following the specifier indicate the name of the **LABDATA** file to be used (for example, ***L* NEWLAB**).
205	Samples were spiked with a mixed ^{205}Pb/ /U/Th spike.
208	Samples were spiked with a ^{208}Pb spike.
235	Samples were spiked with a ^{235}U spike (208-spiked samples only).
233	Samples were spiked with a mixed ^{233}U-^{236}U-spike (208-spiked samples only).
TU	Samples were total-spiked with U(Th).
PU	Samples were spiked for U (and Th) in the Pb-spiked aliquot.
SAMSPK	Raw data for any ^{233}U-^{236}U spiked samples will be in the form of Sample-238/Spike-233 ratios rather than the raw 233/236 and 233/238 ratios.
368	Raw data for any ^{233}U-^{236}U spiked samples will be in the form of raw 233/236 and 233/238 ratios.

Note that if you want to reduce just part of the data in a raw-data file, you must include the row numbers of the appropriate embedded specifiers in the sample numbers that you request. Otherwise, **PBDAT200** will never access the embedded specifiers to be able to do what you want. So if the embedded specifiers of interest occur in, say, row 13 of the raw-data spreadsheet followed by the actual data in rows 14 through 20, you would have to include the "sample number" for row 13 for the embedded specifiers to work. You'll be able to tell which "sample number" to use from the printout or display when you access the raw-data file from **PBDAT200**.

STORING VISICALC RAW-DATA FILES:

Once you've entered all of your data in your raw-data spreadsheet, you should store it in two different ways. First, store the file with the **/SS** command. You can retrieve this type of file with the normal **/SL VISICALC** command, and then edit or add to the data in the spreadsheet. Second, store the file with the **/PF** command. You'll want to store the entire spreadsheet, so you'll have to know where the lower-right corner of the spreadsheet is. If you aren't familiar with **VISICALC**, You should read the explanation of **/PF** files in the **VISICALC** documentation.

Make sure that the PRINTER WIDTH is 80 when you store a **/PF** file. This is the default value (the one that is used when **VISICALC** is first loaded into memory), but might have been changed if someone has previously printed out the spreadsheet using the small-print option of the printer. See either the **VISICALC** or **ISOPLOT200** documentation to see how to change the PRINTER WIDTH.

/PF raw-data files can be read by **PBDAT200** (and by **ISOPLOT200**), but can't be edited or added to. When **VISICALC** asks you to enter a name for the **/PF** file, make sure that you use only letters or numbers in the file name. Characters such as slashes or underscores won't work. You can use exactly the same name for the **/PF** file as the **/SS** file, if you like.

REDUCING DATA FROM A VISICALC RAW-DATA FILE:

To reduce data from a **VISICALC** raw-data file, press the **DATAFILE** softkey (**k4**) from the Top-Level screen. The **DATAFILE** screen will appear as shown below:

Press k0 for a catalog of the disk in the left-hand drive.

Press k1 for a cataog of the disk in the right-hand drive.

Press k4 to load a VISICALC datafile into memory.

Press k6 to print out the datafile on the printer.

Press k7 to cancel k6.

Press k8 for HELP.

Press k9 to escape.

CATALOG Dr#0	CATALOG Dr#1			LOAD DATAFILE
	PRINT DATA		HELP	ESCAPE

Softkeys **k0** or **k1** will give you a catalog of all of the possible raw-data files on the disk in either drive. Only those files stored from **VISICALC** as a **/PF** file will appear in the catalog. A typical catalog will look like:

VISICALC /PF FILES ON DRIVE #0

#1 -- JAB_ORES
#2 -- LARAMIE
#3 -- TRIALFILE
#4 -- PUEBLO_ORES
#5 -- SrCalibr
#6 -- NBS987_RPT

ENTER FILE# TO BE LOADED...

If you want to load one of the files in the catalog into memory, just enter the number of that file as it appears in the catalog. Otherwise, press the **ESCAPE** softkey.

If you already know the name of the file that you want to load, press the **LOAD DATAFILE** softkey (**k4**) from the **DATAFILE** screen, and the program will ask you for the name of the file and the disk-drive number.

After you enter the raw-data file to be loaded, the program will load the file into memory, displaying on the CRT the sample names of that file as they are accessed. If you pressed the **PRINT DATA** softkey from the **DATAFILE** screen, the sample names will also be printed out on the printer, as in the example below:

LARAMIE RANGE ZIRCONS, REV. 6/18/85, 2620 MY INITIAL

SET#	NAME
1	*L* LAB109
2	*205* *235*
3	LR-44 Zr-A1
4	LR-44 Zr-B2
5	LR-44 Zr-C1
7	
8	*208* *233* *TU*
9	LR-2B Zr-A1
10	LR-2B Zr-A2
11	LR-2B K-FELDSPAR
12	LR-2B MONAZ.#1

The top line of the CRT shows the title of the raw-data file that you put in the top row of the raw-data spreadsheet.

Note the embedded specifiers, so that samples 3 through 5 will be reduced assuming a mixed 205/235/230 spike, and samples 9 through 12 reduced assuming total-spiking for U-Th and using 200 and 233/236 spikes. The embedded specifiers in the first row will cause **LABDATA** file LAB109 to be accessed and used for the data-reduction.

You can now reduce the data in the raw-data file. The CRT display will be:

DATA REDUCTION FROM A RAW-DATA DATAFILE:
(Raw-data file now in memory is PUEBLO_ORES)

ENTER DATAFILE NUMBERS FOR SAMPLES TO BE REDUCED...
Separate first & last sample numbers of a continuous sequence with a comma, separate different continuous sequences or individual samples with a semicolon, for example, 1,5;12,15;21. Be sure to include rows with embedded specifiers.

Press k3 for ALL datafile sets in memory,
Press k4 to access a new raw-data file.

			ALL	NEW
				ESCAPE

If you want to reduce data for all of the samples in the raw-data file, press the **ALL** softkey (**k3**). If you want to reduce only part of the data, indicate the sample-numbers of continuous sequences of data by entering the first and last number of the sequence separated by a comma, and indicate discrete sample-numbers or the start of a different continuous sequence by a semicolon. So to specify that sample numbers 1 though 6, then 9, then 12 through 15 be reduced, you would enter **1,6;9;12,15.**

Remember to include rows containing any embedded specifiers if you want those embedded specifiers to take effect. Remember also that once an embedded specifier is acted upon, it remains in effect until specifically cancelled by either another embedded specifier or by softkey-commands from the Top-Level Screen.

After you've specified which samples in the datafile to reduce, the program will display the Initial-Pb Ratios **FORM.** Enter the initial-Pb ratios as discussed earlier (or **ESCAPE** if you don't want apparent ages to be calculated for any of the samples). The data will then be reduced, and either displayed on the CRT or printed out on the printer, depending on whether you selected the **USE PRINTER** or **USE CRT** option from the Top-Level screen.

After the datafile-data has been reduced, the CRT will query:

IF YOU WANT TO STORE THIS DATA AS A REDUCED-DATA FILE,
ENTER THE FILE NAME. OTHERWISE JUST PRESS CONTINUE.

If you want the reduced data stored in a data file that is compatible with the **ISOPLOT200** plotting program (Ludwig, 1985b), enter a name for the reduced-data file. The file name must consist only of letters, numbers, and the underscore character. **PBDAT200** will then ask you which disk-drive to use, and what you want to use as a title for the reduced-data file. This title (up to 80 characters long) will be displayed by **ISOPLOT200** when you access the file, so you can be fairly descriptive (date when reduced, initial-Pb used, types of samples...). The column-headings of the reduced-data file are shown in figures 5 and 6.

USING LABDATA FILES

A **LABDATA** file is a data file that contains the data for a laboratory's spikes, typical blanks, and typical mass-discriminations of isotope-ratio measurements (figure 7). If necessary, you can define several **LABDATA** files for the various spikes or other variables that might be used by your lab.

To access the **LABDATA** screen, press the **LABDATA** softkey (**k3**) from the Top-Level screen. The display will then be:

PRESS N TO DEFINE A NEW LABDATA FILE

PRESS L TO LOAD ANOTHER LABDATA FILE INTO MEMORY

PRESS P TO PRINT OR DISPLAY A LABDATA FILE

PRESS R TO RE-NAME A LABDATA FILE

PRESS THE APPROPRIATE SOFTKEY TO EDIT DATA FOR THE CURRENT LABDATA FILE

U233 Spike	Pb208 Spike	Pb205 Spike	U235 Spike	Th230 Spike
Mass Discr	Blanks	Store File	HELP	ESCAPE

DEFINING A NEW LABDATA FILE:

To define a new **LABDATA** file, press the **N** key from the **LABDATA** screen. The computer will ask you which spikes you wish to define, and present you with a **FORM** for each spike. The spike **FORM**s will require the concentrations (in moles per gram) of the major spike-isotope, the ratios of the isotopes in the spike (these must have already been corrected for mass-discrimination bias), and the uncertainties the concentrations. For most purposes, you should assign concentration uncertainties of zero, unless you have significant random errors (such as weighing errors) in your spike delivery.

After you've defined the spikes for the new **LABDATA** file, **PBDAT200** will display **FORM**s for blanks and for mass discrimination. The BLANKS **FORM** will require you to enter typical uncertainties (in percent of the amount) for any assigned Pb, U, and Th blanks, as well as the Pb-isotope ratios of the Pb-blank, the uncertainty (absolute this time, not percent) in these ratios, and the correlations of the ratio-uncertainties.

Realistic uncertainties in the blank amounts are typically very high -- 30% to 100% for Pb, and 100% or more for very low U and Th blanks. The correlation between the uncertainties of the Pb-blank 206/204 and 207/204 ratios is generally rather high (0.7-.9), since common leads from random ore deposits in general will have highly correlated 206/204 and 207/204 ratios. This is true also for the 206/204-208/204 uncertainty correlation, but to a lesser degree (due to the effect of variable Th/U ratios for the sources of base-metal ore deposits).

The mass-discrimination **FORM** requires estimates of typical mass-discrimination (arising during measurement in the mass spectrometer) for your Pb, U, and Th runs, in percent per mass-unit. You'll also need to assign uncertainties in your estimates, in absolute values. So if your typical mass-discrimination for Pb runs is 0.11% per mass unit with a possible range (2-sigma) of from 0.06% to 0.16%, you would enter the uncertainty as 0.05.

OTHER LABDATA FILE OPERATIONS:

You can use the softkeys of the **LABDATA** screen to edit the values for the spikes, mass-discriminations, or blanks of the **LABDATA** file in memory. If you want to store your changes on a disk, remember to press the **Store File** softkey (**k7**) before you return to the Top-Level screen.

To switch from one **LABDATA** file to another, press the **L** key from the **LABDATA** screen. You can inspect the values for any **LABDATA** file by pressing the **P** key, or change the name of a **LABDATA** file in memory with the **R** key (remember to store the changed file back on the disk, though).

REFERENCES

Ludwig, K.R., 1980, Calculation of uncertainties of U-Pb isotope data: Earth Planetary Science Letters, v. 46, p. 212-220.

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Stacey, J.S., and Kramers, J.D., 1975, Approximation of terrestrial lead isotope evolution by a two-stage model: Earth Planetary Science Letters, v. 26, p. 207-221.

FIGURE CAPTIONS

Figure 1: Example printout of the raw and reduced data for a single sample, spiked with Pb-208 and U-235/Th-230.

Figure 2: Key (taken from the program list) to types of data in the columns of a raw-data **VISICALC** spreadsheet. The column-letter is given by the column labelled **VCcol**. a) For Pb-208 or Pb-206 spiked samples. b) for samples spiked with a mixed Pb-205/U/Th-230 spike.

Figure 3: Printout of **TEMPLATE** spreadsheet, showing column-headings as they appear in the raw-data spreadsheets.

Figure 4: Example of a raw-data **VISICALC** spreadsheet for zircon samples spiked with Pb-208 and U-233/236.

Figure 5: Key (taken from the program list) of column-headings for a reduced-data file created by **PBDAT200**.

Figure 6: Column-headings for a reduced-data file as they will appear when accessed by **ISOPLOT200**.

Figure 7: Example of a **LABDATA** printout.

SAMPLE: Example of Reduced-Data Printout

	206/204	%err	206/207	%err	206/208	%err
UNSPKD	1023.5	1.6	10.112	.021	18.689	.031
SPIKED	—	—	9.998	.042	.21442	.011
SPIKE	17.9		.4258		.0001441	

BLANK: 6/4=18.970+/-1.00 7/4=15.730+/- .20 8/4=39.180+/-1.50

.55204 G Pb-208 V spiked, @1.1059E-09 +/- .10% moles 208/G
.03215 G U-235 IV spiked, @2.3695E-08 +/- .05% moles 235/G
.02527 G Th-230 II spiked, @7.9810E-08 +/- 0.00% moles 230/G

SAMPLE WT.	TOTAL-AL.	Pb-UNSPKD AL.	Pb-SPKD AL.
.001234	1.00098	.67984	.32114

Pb-Unspiked Aliquot, Corrected for .54+/-.32 nG Pb-Blank,
and .14+/-.05 %/a.m.u. Mass-Discrimination

206/207	206/208	206/204	207/204	208/204
10.277	20.453	1174	114.23	57.402
+/-1.07%	+/-5.9%	+/-8.88%	+/-7.83%	+/-3.38%

Error-Correls: 207/204-206/204=.99956 208/204-206/204=.924435

Moles Pb Per Gram:

206	207	208	204	TOTAL
3.32648E-07	3.23673E-08	1.62644E-08	2.83344E-10	3.81563E-07
+/-.146%				

3.6 nG Common-Pb in Unspkd Al. ——— (4.34 PPM)

PPM Total Pb = 78.657 Pb-Spiked Aliquot Blank = .2 nG

238/235 = .7432 +/- .054 % 232/230= .0246 +/- .11 %
.67 nG U-Blank, 1.3 nG Th-Blank U-Th SPIKED-AL.= .32114 Grams

	238	235	232
Moles Per Gram:	1.4401E-06	1.0444E-08	1.0521E-7

345.28 PPM Uranium (+/-.456%)
24.41 PPM Thorium (+/-.6%) Th/U=.0707

238/204= 5082.5 235/204= 36.861 (+/-9.03%)
232/204= 371.3 (+/-9.04%)

Rho(U/4-6/4)= .998494 Rho(U/4-7/4)= .983051 Rho(Th/4-8/4)= .900933

Radiogenic-Pb	206*	207*	208*
Moles Per Gram:	3.2735E-07	2.7939E-08	5.3188E-09

Initial-Pb: 6/4=18.7 +/- 0 7/4=15.63 +/- 0
8/4=38.63 +/- 0 RHO(6/4-7/4) = .9

	206/238	207/235	207/206	208/232
RATIOS:	.227313	2.67497	.085348	.050555
ERRORS:	.48%	.565%	.27%	4.03%
AGES (Ma):	1320.4	1321.6	1323.5	996.83

Rho (207/235-206/238) = .878686

****

FIGURE 1

```
348   ! ############ FOR SAMPLES SPIKED WITH Pb-208 OR Pb-206 ONLY ################
#
354   !
360   !  J  VCcol              SIGNIFICANCE
366   !
372   !
378   !  1    C     sample-weight (g)  -  actually dissolved
384   !  2    D     weight of solution of dissolved sample before aliquoting
390   !  3    E     weight of Pb-unspiked liquid aliquot of dissolved sample
396   !  4    F     weight of Pb-spiked liquid aliquot   "     "        "
408   !  5    G     grams Pb-spike delivered to 4
414   !  6    H     grams uranium spike delivered either to 2 or 4
420   !  7    I       "   thorium  "       "          "      "    "
426   !  8    J     unspiked-aliquot 206/204
432   !  9    K     %uncertainty in 8 (not incl. mass-discr. err)
438   !  10   L     unspiked-aliquot 206/207
444   !  11   M     %uncertainty in 10 (not incl. mass-discr. err)
450   !  12   N     unspiked-aliquot 206/208
456   !  13   O     %uncertainty in 12 (not incl. ...)
462   !  14   P     Pb-spiked aliquot 206/204
468   !  15   Q     % uncertainty in 14 (not incl....)
474   !  16   R     Pb-spiked aliquot 206/207
480   !  17   S     % uncertainty in 16 (not incl....)
486   !  18   T     Pb-spiked aliquot 206/208
492   !  19   U     % uncertainty in 18 (not incl....)
498   !  20   V     238/235 of U-spiked aliquot (spiked with 235), OR
504   !   "   "     sample-238/spike-233 of U-spiked aliquot (have SAM/SPK ratio)
510   !   "   "     OR 233/238 of U-spiked aliquot (no SAM/SPK ratio)
516   !  21   W     %uncertainty in 20 (not incl...)
522   !  22   X     232/230 of Th-spiked aliquot
528   !  23   Y     %uncertainty in 22 (not incl...)
534   !  24   Z     Pb blank of Pb-unspiked aliquot, in nanograms
540   !  25   AA    U blank of U-spiked aliquot, in nanograms
546   !  26   AB    Th blank of Th-spiked aliquot, in nanograms
552   !  27   AC    233/236 of U-spiked aliquot (only if no SAM/SPK ratio)
558   !  28   AD    %uncertainty in 233/236
```

FIGURE 2A

```
570   !  ########### FOR MIXED Pb205/U/Th230 SPIKED SAMPLES ONLY ##############
576   !   1    C      sample weight (g)
582   !   2    D      weight (g) of mixed Pb205-U235-Th230 spike delivered
588   !   3    E      observed 206/204 ratio
594   !   4    F      %uncertainty in 206/204, not incl. mass-discr. err
600   !   5    G      observed 206/207 ratio
606   !   6    H      %uncertainty in 206/207, not incl. mass-discr. err
612   !   7    I      observed 206/208 ratio
618   !   8    J      %uncertainty in 206/208, not incl. mass-discr. err
624   !   9    K      observed 206/205 ratio
630   !   10   L      %uncertainty in 206/205, not incl. mass-discr. err
636   !   11   M      observed 238/235 ratio (or sam238/spk233, or 233/238)
642   !   12   N      %uncertainty in above, not incl. mass-discr. err
648   !   13   O      observed 232/230 ratio
654   !   14   P      %uncertainty in 232/230, not incl. mass-discr. err
660   !   15   Q      Pb blank for Pb run, in nanograms
666   !   16   R      U blank for U run, in nanograms
672   !   17   S      Th blank for Th run, in nanograms
678   !   18   T      233/236 of U-spiked aliquot (only if no SAM/SPK ratio)
684   !   19   U      % uncertainty in 233/236
690   !   20-30       not used for Pb-205 spiked samples
```

FIGURE 2B

A	B	C	D	E	F	G	H	I	J	K	L	M	N

TEMPLATE FOR RAW Pb-U-Th DATA, SPIKED WITH 233/236

SAMPLE	NAME	SAMPLE WT (G)	TOTAL AL (G)	Pb-UNSPK AL (G)	Pb-SPKD AL (G)	Pb-SPIKE (G)	U-SPIKE (G)	Th-SPIKE (G)	Pb-UNSP 206/204	1σrr	Pb-UNSP 206/207	1σrr	Pb-UNSP 206/208

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	BB
							OR: E/S						

1σrr	Pb-SPKD 206/204	1σrr	Pb-SPKD 204/207	1σrr	Pb-SPKD 206/208	1σrr	SAMPLE238 /SPK233	1σrr	Th-SPKD 232/230	1σrr	Pb BLANK (ng)	U BLANK (ng)	Th BLANK (ng)

AC (if no SAM/SPK) 233/236	AD 1σrr

A	B	C	D	E	F	G	H	I	J	K	L	M	N

TEMPLATE FOR RAW Pb-U-Th DATA, SPIKED WITH Pb-205 MIXED SPIKE

SAMPLE	NAME	SAMPLE WT (G)	Pb-205 (G)	204/204	1σrr	206/207	1σrr	206/208	1σrr	206/205	1σrr	238/235	1σrr

O	P	Q	R	S	T	U
					(if no SAM/SPK)	

232/230	1σrr	Pb BLANK (ng)	U BLANK (ng)	Th BLANK (ng)	233/236	-1σrr

FIGURE 3

EXAMPLE OF A RAW-DATA SPREADSHEET FOR ZIRCON SAMPLES SPIKED WITH Pb208 AND U233/236

A	B	C	D	E	F	G	H	I	J	K	L	M	N
SAMPLE	NAME	SAMPLE WT (G)	TOTAL AL (G)	Pb-UNSPK AL (G)	Pb-SPKD AL (G)	Pb-SPIKE (G)	U-SPIKE (G)	Th-SPIKE (G)	Pb-UNSP 206/204	1err	Pb-UNSP 206/207	1err	Pb-UNSP 206/208
RLH ZIRCOLAB													
82084 82334													
0SAMSPK0													
FARANDO	P50R100	.001789		.23143	.16222	.10223	.10047	.0534	6510	1.4	5.5651	.011	6.6035
FARANDO	P100R150	.001516		.26694	.13867	.20049	.10852	.05322	6826	1.1	5.5606	.014	6.4664
FARANDO	P150R200	.001438		.25833	.15176	.18467	.11445	.05366	8360	1.3	5.5696	.012	6.4538
FARANDO	P200NM	.00185		.26195	.11326	.16794	.12368	.05335	7280	1.4	5.5759	.034	6.4937
FARANDO	P200M	.001963		.21738	.16022	.17025	.12817	.05297	11720	2	5.6104	.006	6.6626
FARANDO	NONAI	4.32E-4		.22345	.14054	.18022	.20133	.21432	14370	3.7	5.6211	.017	.14422

O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1err	Pb-SPKD 206/204	1err	Pb-SPKD 206/207	1err	Pb-SPKD 206/208	1err	SAMPLE238 /SPK233	1err	Th-SPKD 232/230	1err	Pb BLANK (NG)	U BLANK (NG)	Th BLANK (NG)
.012	5800	1.1	5.5534	.005	1.8302	.003	2.255	.73	.035937	.14	.3	.01	.01
.024	4197	3.8	5.5217	.01	1.3807	.004	1.556	.08	.11968	.1	.3	.01	.01
.0054	6104	.6	5.5509	.005	1.4245	.002	1.5977	.27	.034888	.24	.3	.01	.01
.021	4419	1	5.5362	.006	1.1754	.003	.93144	.074	.10028	.074	.3	.01	.01
.013	5780	1	5.5735	.004	2.2252	.004	2.4534	.12	.082743	.11	.3	.01	.01
.024			5.61543	.038	.05217	.12	3.2173	.064	10.432	.328	.2	.01	.01

FIGURE 4

```
702   ! DEFINITIONS OF OUTPUT (PROCESSED-DATA) VARIABLES:  ARRAY Red(I,J)
708   ! ARRAY Red(I,J); NUMERIC-FILE COLUMN# J, VISICALC COLUMN VCcol
714   !
720   !  J   VCcoL            SIGNIFICANCE
726   !  1    C     Sample-weight (g) or, if one exists, gross-weight
732   !              (gross-wt is weight of total ground sample before splitting).
738   !  2    D     ppm U
744   !  3    E     ppm Th
750   !  4    F     ppm Pb
756   !  5    G     ppm common-Pb
762   !  6    H     Nanomoles Pb-206 per gram
768   !  7    I     Raw (uncorrected) 206/204 of unspiked-aliquot
774   !  8    J     Blank & discr.-corrected sample 206/204
780   !  9    K       "          "          "    207/204
786   !  10   L       "          "          "    208/204
792   !  11   M     Radiogenic Pb-206/U-238
798   !  12   N     Radiogenic Pb-207/U-235
804   !  13   O     Radiogenic Pb-207/Pb-206
810   !  14   P     Radiogenic Pb-208/Th-232
816   !  15   Q     206/238 age (Ma)
822   !  16   R     207/235    "
828   !  17   S     207/206    "
834   !  18   T     208/232    "
840   !  19   U     Mu (238/204)
846   !  20   V     Nu (235/204)
852   !  21   W     232/204
858   !  22   X     %uncertainty in [U]
864   !  23   Y           "          [Th]
870   !  24   Z           "          [Pb-204]
876   !  25   AA          "          [Pb-206]
882   !  26   AB          "          206/204
888   !  27   AC          "          207/204
894   !  28   AD          "          208/204
900   !  29   AE    Error-correlation for 206/204-207/204
906   !  30   AF          "                206/204-208/204
912   !  31   AG    %uncertainty in radiogenic 206/238
918   !  32   AH          "          "      207/235
924   !  33   AI          "          "      207/206
930   !  34   AJ    Error-correlation for 206/238-207/235
936   !  35   AK    %uncertainty in radiogenic 208/232
942   !  36   AL    %uncertainty in Mu and Nu (238/204 & 235/204)
948   !  37   AM    %uncertainty in 232/204
954   !  38   AN    Error-correlation for Alpha-Mu
960   !  39   AO          "                Beta-Nu
966   !  40   AP          "                Gamma-232/204
```

FIGURE 5

COLUMN-NAME LISTING FROM 'ISOPLOT200' FOR A REDUCED-DATA FILE

LARAMIE RANGE ZIRCONS, REDUCED DATA, 6/18/85

COLUMN	COLUMN-NAME	COLUMN	COLUMN-NAME
C	SAMPLE WT. (g)	W	232/204
D	ppm U	X	[U] %err
E	ppm Th	Y	[Th] %err
F	ppm Pb	Z	[204] %err
G	COMMON-Pb ppm	AA	[206] %err
H	Pb-206/g nanomoles	AB	206/204 %err
I	206/204 (raw)	AC	207/204 %err
J	206/204 (corr.)	AD	208/204 %err
K	207/204 (corr.)	AE	6/4-7/4 Rho
L	208/204 (corr.)	AF	6/4-8/4 Rho
M	206/238 (rad.)	AG	206/238 %err
N	207/235 (rad.)	AH	207/235 %err
O	207/206 (rad.)	AI	207/206 %err
P	208/232 (rad.)	AJ	6/8-7/5 Rho
Q	206/238 age (Ma)	AK	208/232 %err
R	207/235 age (Ma)	AL	238/204 %err
S	207/206 age (Ma)	AM	232/204 %err
T	208/232 age (Ma)	AN	Nu-Alpha Rho
U	238/204	AO	Nu-Beta Rho
V	235/204	AP	Th4-Gamma Rho

FIGURE 6

```
DATA FROM LABDATA FILE  NEWLAB:

Pb-208 Spike  (Pb-208 V):

[208] = 1.1059E-09  +/-  .10% moles/g
(not a mixed Pb/U spike)
206/204= 17.9          206/207= .4258          206/208= .0001441

Pb-205 mixed spike   (Pb-205a):

[205] = 3.9485E-11  +/-  .50% moles/g
[235] = 1.7055E-09  +/-  .50% moles/g
[230] = 1.2774E-09  +/-  .50% moles/g

206/205 = .001128                    238/235 = .0006119951
206/204 = 20.3                       232/230 = .0003921569
206/207 = 1.21
206/208 = .4846

U-235 spike  (U-235 IV):

[235] = 2.3695E-08  +/-  .05% moles/g
238/235 = .0007905

Mixed U-233/U-236 spike  (U-233a):

[233] = 4.9657E-09  +/-  .10% moles/g
233/236 = 1.0172        233/238 = 2534

Th-spike  (Th-230 II):

[230] = 7.9810E-08  +/-  .15% moles/g
232/230 = .001292

Average mass-discrimination during mass-spectrometer runs, in %/a.m.u. —

Pb:   .14 +/- .05       U:  .25 +/- .15          Th:  .25 +/- .3

Average Blanks:

Uncertainty in assigned amount:  Pb - 60%      U - 100%       Th - 100%

Pb blank ratios and uncertainties:
206/204 = 18.97+/-1       207/204 = 15.73+/-.2       208/204 = 39.18+/-1.5
Error-Correlations: 206/204-207/204= .8      206/204-208/204= .7
```

Figure 7

APPENDIX: PROGRAM LIST OF PBDAT200

```
6     Rev$="SEPT 3, 1985"  ! Version CI
12    ! ***************************** PBDAT ************************************
18    !
24    ! HP-9816 program to reduce raw Pb-U-Th isotope ratios and lab-data to
30    !  blank- and discrimination-corrected ratios and concentrations, together
36    !  with errors and error-correlations.
42    ! Error and error-correlation calculations follow EPSL V. 46, P. 212-220,
48    !  1980.
54    ! Possible spikes include a Pb-205 mixed spike and a U-233/236 mixed spike
60    !
66    ! Assumes printer is at 701, disk-drive is a dual single-sided HP-9121.
72    !
78    OUTPUT KBD;"SCRATCH KEY";CHR$(255)&CHR$(88)&CHR$(255)&CHR$(75);
84    TRACE OFF
90    PRINTER IS CRT
96    PRINT USING "K,/""Please wait a few seconds..."
102   !
108   ! Variables from LabData File:
114   !
120   !  Mixed_spike                 mixed Pb-208/U(/Th) spike? (0/1)
126   !  Pbdisc                      %/a.m.u. mass-discr. for Pb
132   !  Udisc                          "          "       "  U
138   !  Thdisc                         "          "       "  Th
144   !  Blank64                     206/204 of blank-Pb
150   !  Blank74                     207/204      "
156   !  Blank84                     208/204      "
162   !  Blank64err                  absolute uncertainty in blank 206/204
168   !  Blank74err                     "          "           "   207/204
174   !  Blank84err                     "          "           "   208/204
180   !  Blank6474_rho               error-correlation for blank 6/4-7/4
186   !  Blank6484_rho                     "          "       "   6/4-8/4
192   !  Pbblank_perr                %uncertainty in ng of Pb blank
198   !  Pbdisc_err                  uncertainty in Pb mass-discr./amu
204   !  Udisc_err                      "      "  U       "
210   !  Thdisc_err                     "      "  Th      "
216   !  Spike64                     Pb-spike 206/204 ratio
222   !  Spike67                        "     "   206/207   "
228   !  Spike68                        "     "   206/208   "
234   !  Spike65                     Pb-205 spike 206/205 ratio
240   !  Spike238235                 U-235 spike 238/235 ratio
246   !  Spike238233                 U-233/236 spike 238/233 ratio
252   !  Spike233236                 U-233/236 spike 233/236 ratio
258   !  Spike232230                 Th   "    232/230    "
264   !  Spike208pg                  moles/g of Pb-208 in spike
270   !  Spike205pg                  moles/g of Pb-205 in spike
276   !  Pbspike_conc_perr           % +/- in Pb-spike concentration
282   !  Spike205pg_perr             % +/- in Pb-205 spike concentration
288   !  Spike235pg                  moles/g of U-235 in U-spike
294   !  Spike230pg                     "        Th-230 in Th-spike
300   !  Spike235pg_perr             % uncertainty in U-235 concentration
306   !  Spike230pg_perr                "          "    Th     "
312   !  Spike233pg                  moles/g U-233 in the U double-spike
318   !  Spike233pg_perr             % uncertainty in U-233 concentration
324   !
330   ! DEFINITIONS OF INPUT (RAW-DATA) DATAFILE VARIABLES
336   ! ARRAY Raw(I,J) & VISICALC COLUMN VCcol
342   !
348   ! ************ FOR SAMPLES SPIKED WITH Pb-208 OR Pb-206 ONLY ****************
```

```
354  !
360  !  J  VCcol            SIGNIFICANCE
366  !
372  !
378  !  1    C    sample-weight (g)  -  actually dissolved
384  !  2    D    weight of solution of dissolved sample before aliquoting
390  !  3    E    weight of Pb-unspiked liquid aliquot of dissolved sample
396  !  4    F    weight of Pb-spiked liquid aliquot    "     "     "
408  !  5    G    grams Pb-spike delivered to 4
414  !  6    H    grams uranium spike delivered either to 2 or 4
420  !  7    I      "    thorium    "       "     "  "  "
426  !  8    J    unspiked-aliquot 206/204
432  !  9    K    %uncertainty in 8 (not incl. mass-discr. err)
438  !  10   L    unspiked-aliquot 206/207
444  !  11   M    %uncertainty in 10 (not incl. mass-discr. err)
450  !  12   N    unspiked-aliquot 206/208
456  !  13   O    %uncertainty in 12 (not incl. ...)
462  !  14   P    Pb-spiked aliquot 206/204
468  !  15   Q    % uncertainty in 14 (not incl....)
474  !  16   R    Pb-spiked aliquot 206/207
480  !  17   S    % uncertainty in 16 (not incl....)
486  !  18   T    Pb-spiked aliquot 206/208
492  !  19   U    % uncertainty in 18 (not incl....)
498  !  20   V    238/235 of U-spiked aliquot (spiked with 235), OR
504  !   "   "    sample-238/spike-233 of U-spiked aliquot (have SAM/SPK ratio)
510  !   "   "    OR 233/238 of U-spiked aliquot (no SAM/SPK ratio)
516  !  21   W    %uncertainty in 20 (not incl...)
522  !  22   X    232/230 of Th-spiked aliquot
528  !  23   Y    %uncertainty in 22 (not incl...)
534  !  24   Z    Pb blank of Pb-unspiked aliquot, in nanograms
540  !  25   AA   U blank of U-spiked aliquot, in nanograms
546  !  26   AB   Th blank of Th-spiked aliquot, in nanograms
552  !  27   AC   233/236 of U-spiked aliquot (only if no SAM/SPK ratio)
558  !  28   AD   %uncertainty in 233/236
564  !
570  !  ********** FOR MIXED Pb205/U/Th230 SPIKED SAMPLES ONLY **************
576  !  1    C    sample weight (g)
582  !  2    D    weight (g) of mixed Pb205-U235-Th230 spike delivered
588  !  3    E    observed 206/204 ratio
594  !  4    F    %uncertainty in 206/204, not incl. mass-discr. err
600  !  5    G    observed 206/207 ratio
606  !  6    H    %uncertainty in 206/207, not incl. mass-discr. err
612  !  7    I    observed 206/208 ratio
618  !  8    J    %uncertainty in 206/208, not incl. mass-discr. err
624  !  9    K    observed 206/205 ratio
630  !  10   L    %uncertainty in 206/205, not incl. mass-discr. err
636  !  11   M    observed 238/235 ratio (or sam238/spk233, or 233/238)
642  !  12   N    %uncertainty in above, not incl. mass-discr. err
648  !  13   O    observed 232/230 ratio
654  !  14   P    %uncertainty in 232/230, not incl. mass-discr. err
660  !  15   Q    Pb blank for Pb run, in nanograms
666  !  16   R    U blank for U run, in nanograms
672  !  17   S    Th blank for Th run, in nanograms
678  !  18   T    233/236 of U-spiked aliquot (only if no SAM/SPK ratio)
684  !  19   U    % uncertainty in 233/236
690  !  20-30     not used for Pb-205 spiked samples
696  !
702  !  DEFINITIONS OF OUTPUT (PROCESSED-DATA) VARIABLES:  ARRAY Red(I,J)
708  !  ARRAY Red(I,J); NUMERIC-FILE COLUMN# J, VISICALC COLUMN VCcol
714  !
720  !  J   VCcoL           SIGNIFICANCE
726  !  1    C    Sample-weight (g) or, if one exists, gross-weight
732  !              (gross-wt is weight of total ground sample before splitting).
738  !  2    D    ppm U
```

```
744   !  3    E    ppm Th
750   !  4    F    ppm Pb
756   !  5    G    ppm common-Pb
762   !  6    H    Nanomoles Pb-206 per gram
768   !  7    I    Raw (uncorrected) 206/204 of unspiked-aliquot
774   !  8    J    Blank & discr.-corrected sample 206/204
780   !  9    K      "          "          "     207/204
786   !  10   L      "          "          "     208/204
792   !  11   M    Radiogenic Pb-206/U-238
798   !  12   N    Radiogenic Pb-207/U-235
804   !  13   O    Radiogenic Pb-207/Pb-206
810   !  14   P    Radiogenic Pb-208/Th-232
816   !  15   Q    206/238 age (Ma)
822   !  16   R    207/235    "
828   !  17   S    207/206    "
834   !  18   T    208/232    "
840   !  19   U    Mu (238/204)
846   !  20   V    Nu (235/204)
852   !  21   W    232/204
858   !  22   X    Zuncertainty in [U]
864   !  23   Y          "         [Th]
870   !  24   Z          "         [Pb-204]
876   !  25   AA         "         [Pb-206]
882   !  26   AB         "         206/204
888   !  27   AC         "         207/204
894   !  28   AD         "         208/204
900   !  29   AE   Error-correlation for 206/204-207/204
906   !  30   AF         "                 206/204-208/204
912   !  31   AG   Zuncertainty in radiogenic 206/238
918   !  32   AH         "                  207/235
924   !  33   AI         "                  207/206
930   !  34   AJ   Error-correlation for 206/238-207/235
936   !  35   AK   Zuncertainty in radiogenic 208/232
942   !  36   AL   Zuncertainty in Mu and Nu (238/204 & 235/204)
948   !  37   AM   Zuncertainty in 232/204
954   !  38   AN   Error-correlation for Alpha-Mu
960   !  39   AO         "                 Beta-Nu
966   !  40   AP         "                 Gamma-232/204
972   !
978   !  VAR  in a variable name indicates a variance, PVAR  indicates a variance in percent-squared, err usua
       lly indicates an absolute error, perr a % error.
984   !
990   OPTION BASE 1
996   COM /Labdata1/ Labdata$[25],Pbspike$[15],Uspike$[15],Thspike$[15],Pb205_spiked,Mixed_spike,Spike205pg,Spi
       ke208pg,Pbspk_conc_perr,Spike64,Spike67,Spike68
1002  COM /Labdata2/ Spike65,Spike235pg,Spike235pg_perr,Spike238235,Spike230pg,Spike232230,Pbdisc,Pbdisc_err,Ud
       isc,Udisc_err,Thdisc,Thdisc_err,Pbblank_perr
1008  COM /Labdata3/ Ublank_perr,Thblank_perr,Blank64,Blank74,Blank84,Blank64err,Blank74err,Blank84err,Blank647
       4_rho,Blank_6484rho,U233_spiked
1014  COM /Labdata4/ Spike233pg,Spike233pg_err,Spike238233,Spike233236
1020  COM /Read_labdat/ Pb208(6),Pb205(13),U235(3),U233(4),Th230(3),Discr(6),Blanks(11),Pb208$[15],Pb205$[15],U
       235$[15],U233$[15],Th230$[15]
1026  COM /Form/ Prompt$(17)[32],Response$(17)[40],Use(17),Range(17,2),Nval(17),Escape
1032  COM /Print/ Printer_ok
1038  COM /Ms/ Ms$(0:1)[15]
1044  Ms$(0)=":HP9121,700,0"  ! Dual single-sided 3.5" disk drive   (left)
1050  Ms$(1)=":HP9121,700,1"  !  "     "      "    "   "    "                (right)
1056  !
1062  COM Raw(100,30),Raw0(100,30),Red(100,40),Temp(30),Lr1$(13)[40],Lr2$(8)[40],Lr3$(14)[40],Lr4$(15)[40],Lr5$
       (15)[40],Lr6$(17)[40],Rawfile$[15]
1068  COM Name$(100)[18],Table$[80],Is$[80],Trialname$[80],Nv(8)
1074  COM S1$[10],S2$[10],S3$[10],Pbraw$(8:19)[15],Have_samspk
1075  DIM In$[80]
1080  !
```

```
1086  ! Default settings are for CRT output, keyboard data-entry, Pb-208 spiked,U-235 spiked.
1092 DATA 0,1,0,0,0,0,0,0,203.973,205.974,206.976,207.977,238.039,232.038,.155125E-3,.98485E-3,.049475E-3,137.88
     ,1
1098 RESTORE 1092
1104 READ Printer,Crt,Datafile,Pb205_spiked,U233_spiked,Kybrd,Init64
1110 READ Aw204,Aw206,Aw207,Aw208,Atwt_u,Atwt_th,Lambda238,Lambda235,Lambda232,Nat_uratio,Have_samspk
1116 PRINTER IS CRT
1122 IF Labdata$="" THEN
1128   CALL Labdata(1)
1134   Transfer_labdat
1140 END IF
1146 !
1152 Choose:Clear
1158 PRINT TABXY(1,1);FNH$("PBDAT");TAB(15);"rev. "&Rev$;TAB(51);"K.R. Ludwig, U.S. Geol. Survey"
1164 PRINT TABXY(1,7);FNCenter$("(asterisks indicate default options)    ")
1170 PRINT TABXY(1,10);FNCenter$("PRESS "&FNH$("k9")&" TO ENTER RAW DATA FROM THE "&FNUn$("KEYBOARD"))
1176 PRINT TABXY(1,12);FNCenter$(" PRESS "&FNH$("k4")&" TO ENTER RAW DATA FROM A "&FNUn$("DATAFILE")&"    ")
1182 PRINT TABXY(16,14);"PRESS "&FNH$("CTRL I")&" TO LOAD & RUN "&FNH$("ISOPLOT")
1188 PRINT TABXY(1,3);"LABDATA file is "&FNH$(Labdata$)
1194 IF Pb205_spiked THEN
1200   IF U233_spiked AND Have_samspk THEN DISP FNH$("SPIKED WITH Pb-205/U-233/236/Th-230 - with SAM/SPK");
1206   IF U233_spiked AND NOT Have_samspk THEN DISP FNH$("SPIKED WITH Pb-205/U-233/236/Th-230 - no SAM/SPK");
1212   IF NOT U233_spiked THEN DISP FNH$("SPIKED WITH Pb-205/U-235/Th-230");
1218 ELSE
1224   DISP FNH$("SPIKED WITH Pb-208");
1230   IF U233_spiked AND Have_samspk THEN DISP FNH$("AND U-233/U-236 - with SAM/SPK");
1236   IF U233_spiked AND NOT Have_samspk THEN DISP FNH$("AND U-233/U-236 - no SAM/SPK");
1242   IF NOT U233_spiked THEN DISP FNH$("AND U-235");
1248 END IF
1254 IF Crt THEN DISP TAB(58);FNH$("CRT IS OUTPUT DEVICE")
1260 IF Printer THEN DISP TAB(55);FNH$("PRINTER IS OUTPUT DEVICE")
1266 OFF KEY
1272 IF Crt=0 THEN ON KEY 5 LABEL "   USE CRT" GOTO Crt_output
1278 IF Crt=1 THEN ON KEY 5 LABEL " USE PRINTER" GOTO Printer_output
1284 ON KEY 9 LABEL "   KEYBOARD" GOTO Keyboard
1290 ON KEY 4 LABEL "   DATAFILE" GOTO Datafile
1296 ON KEY 0 LABEL " CHANGE Pb0" GOTO Changepb0
1302 ON KEY 1 LABEL " Pb-208 SPIKED" GOTO Pb_208
1308 ON KEY 3 LABEL "   LABDATA" GOTO Call_labdata
1314 ON KEY 7 LABEL " U-233 SPIKED" GOTO U_233
1320 ON KEY 17 GOTO Samspk
1326 ON KEY 2 LABEL " U-235 SPIKED" GOTO U_235
1332 ON KEY 6 LABEL " Pb-205 SPIKED" GOTO Pb_205
1338 ON KEY 8 LABEL "    HELP" GOTO Call_help1
1344 ON KBD GOTO 1362
1350 Klabel:GOTO 1350
1356 !
1362 K=FNGet_key
1368 OFF KBD
1374 SELECT K
1380 CASE 8      ! CTRL-H
1386 Call_help1:CALL Help1
1392   GOTO Choose
1398 CASE 9      ! CTRL-I
1404   Clear
1410   OFF KEY
1416   OFF KBD
1422   DISP "Loading "&FNH$("ISOPLOT")&"..."
1428   ON ERROR GOTO 1446
1434   FOR I=0 TO 1
1440     LOAD "ISOPLOT"&Ms$(I),1
1446   NEXT I
1452   OFF ERROR
1458   Clear
1464   Bad_input("CAN'T FIND ISOPLOT DISK ON EITHER DRIVE...")
```

```
1470   GOTO Choose
1476 CASE ELSE
1482   Clunk
1488   GOTO 1344
1494 END SELECT
1500 !
1506 Call labdata:CALL Labdata(0)
1512 GOTO Choose
1518 !
1524 ! ************* Input data from the keyboard ***********************
1530 !
1536 Keyboard:I=1
1542 Kybrd=1
1548 OFF KEY
1554 OFF KBD
1560 OFF KNOB
1566 Clear
1572 FOR J=1 TO 30
1578   Raw(I,J)=0
1584 NEXT J
1590 IF NOT Pb205_spiked THEN
1596   DATA SAMPLE NAME,"",SAMPLE WEIGHT (grams),TOTAL-ALIQUOT WEIGHT (grams),"    (enter only if appropriate)
       ",Pb-UNSPIKED ALIQUOT (grams)
1602   DATA Pb-SPIKED ALIQUOT (grams),U/Th SPIKED IN TOTAL (1),"       OR Pb-SPIKED (2) ALIQUOT",""
1608   DATA Pb-SPIKE DELIVERED (grams),U-SPIKE DELIVERED (grams),Th-SPIKE DELIVERED (grams)
1614   DATA ??,"",1,"",--,0,1,"",2,"",0,0,0
1620   DATA -1,-1,0,0,0,1000,0,0,-1,-1,0,1000,0,1000,0,0,1,2,0,0,0,10,0,10,0,10
1626   DATA  1,0,1,0,1,1,1,0,1,0,1,1,1
1632   RESTORE 1596
1638   REDIM Prompt$(13),Response$(13),Range(13,2),Use(13),Nval(13)
1644   READ Prompt$(*),Response$(*),Range(*),Use(*)
1650   Form(Lr1$(*),1,2)
1656   IF Escape THEN Choose
1662   MAT Lr1$= Response$
1668   Trialname$=Response$(1)
1674   Name$(I)=Response$(1)[1,MIN(LEN(Response$(1)),18)]
1680   IF Name$(I)="" THEN Name$(I)=" "
1686   Raw(I,1)=Nval(3)                        ! sample weight
1692   Raw(I,2)=Nval(5)                        ! total-al. weight
1698   Raw(I,3)=Nval(6)                        ! Pb-unspiked al. weight
1704   Raw(I,4)=Nval(7)                        ! Pb-spiked   al. weight
1710   IF Raw(I,2)=0 THEN Raw(I,2)=Raw(I,3)+Raw(I,4)
1716   Total_uspiked=2-Nval(9)                 ! Total-spiked for U/Th?
1722   Raw(I,5)=Nval(11)                       ! grams Pb-spike
1728   Raw(I,6)=Nval(12)                       ! grams U-spike
1734   Raw(I,7)=Nval(13)                       ! grams Th-spike
1740 ELSE   ! spiked with a mixed Pb-205/U-235/Th-230 spike
1746   DATA  Pb-205 SPIKED SAMPLE: ,"","",SAMPLE NAME,"",SAMPLE WEIGHT (grams),"",Pb-205 SPIKE DELIVERED (gr
       ams)
1752   DATA "","","","",??,"",1,"",??
1758   DATA 0,0,0,0,0,0,-1,-1,0,0,1E-9,10,0,0,0,10
1764   DATA 0,0,0,1,0,1,0,1
1770   RESTORE 1746
1776   REDIM Prompt$(8),Response$(8),Range(8,2),Use(8),Nval(8)
1782   READ Prompt$(*),Response$(*),Range(*),Use(*)
1788   Form(Lr2$(*),1,3)
1794   IF Escape THEN Choose
1800   MAT Lr2$= Response$
1806   Trialname$=Response$(4)
1812   Name$(I)=Response$(1)[1,MIN(LEN(Response$(4)),18)]
1818   IF Name$(I)="" THEN Name$(I)=" "
1824   Raw(I,1)=Nval(6)          ! sample weight
1830   Raw(I,5)=Nval(8)          ! spike weight
1836   Raw(I,6)=Nval(8)          ! spike weight
1842   Raw(I,7)=Nval(8)          ! spike weight
```

```
1848   Raw(I,3)=0                ! Pb-unspiked aliquot
1854   Raw(I,2)=1                ! Total aliquot
1860   Raw(I,4)=1                ! Pb-spiked aliquot
1866 END IF
1872 !
1878 IF NOT Pb205_spiked THEN
1884   IF Raw(I,5) THEN
1890     DATA  Pb-UNSPIKED ALIQUOT: ,"","                206/204","                    Zerror","","
               206/207"
1896     DATA "                    Zerror","," "                    206/208","                    Zerror"
1902     DATA "","       Pb-BLANK (nanograms)","","(ERRORS MUST BE 2-SIGMA)"
1908     DATA "","","?? ?? ?? 
```

```
2214   END IF
2220   Form(Lr4$(*),Fparam,Helper)
2226   IF Escape AND NOT Pb205_spiked THEN Choose
2232   IF Escape AND Pb205_spiked THEN Udata
2238   MAT Lr4$= Response$
2244   Raw(I,14)=Nval(3)      ! 206/204
2250   Raw(I,15)=Nval(4)      ! %err
2256   Raw(I,16)=Nval(6)      ! 206/207
2262   Raw(I,17)=Nval(7)      ! %err
2268   Raw(I,18)=Nval(9)      ! 206/208
2274   Raw(I,19)=Nval(10)     ! %err
2280   IF Raw(I,24)=0 THEN Raw(I,24)=Nval(15)  ! Pb blank
2286   IF Pb205_spiked THEN
2292     Raw(I,8)=Nval(12)    ! [illegible]/205
2298     Raw(I,9)=Nval(13)    ! [illegible]err
2304   ELSE
2310     IF Raw(I,10)=0 AND Raw(I,16)=0 THEN
2316       Clunk
2322       Bad_input("MUST HAVE AT LEAST ONE 206/207 VALUE")
2328       GOTO Choose
2334     END IF
2340     IF Raw(I,8)=0 AND Raw(I,14)=0 THEN Raw(I,14)=18.8 ! default value for blanks
2346     IF Raw(I,18)=0 THEN
2352       Clunk
2358       Bad_input("MUST HAVE A SPIKED-ALIQUOT 206/208 VALUE")
2364       GOTO Pbspiked_ratios
2370     END IF
2376   END IF
2382 END IF
2388 !
2394 Udata:IF Raw(I,6) OR Raw(I,7) THEN
2400   DATA " U-SPIKED ALIQUOT: ","","         233/236","         %error","","         233/238","
       %error"
2406   DATA " U-SPIKED ALIQUOT: ","","","","         238/235","         %error"
2412   DATA " U-SPIKED ALIQUOT: ","","","","    SAMPLE-238/SPIKE-233","         %error"
2418   DATA "","         232/230","                %error",""
2424   DATA " U- BLANK (nanograms)","  Th-BLANK (nanograms)","",(ERRORS MUST BE 2-SIGMA)
2430   DATA "","","","","
```

```
2598     Helper=7
2604   END IF
2610   !
2616   Form(Lr5$(*),1,Helper)
2622   IF NOT Escape AND SUM(Nval) THEN
2628     MAT Lr5$= Response$
2634     IF U233_spiked AND NOT Have_samspk THEN
2640       Raw(I,27)=Nval(3)
2646       Raw(I,28)=Nval(4)
2652     END IF
2658     Raw(I,20)=Nval(6)  ! 238/235 or SAM/SPK or 233/238
2664     Raw(I,21)=Nval(7)  ! Zerror
2670     Raw(I,22)=Nval(9)  ! 232/230
2676     Raw(I,23)=Nval(10) ! Zerror
2682     Raw(I,25)=Nval(12) ! U blank
2688     Raw(I,26)=Nval(13) ! Th blank
2694   END IF
2700 END IF
2706 !
2712 IF Raw(I,6) AND Raw(I,20) AND Raw(I,5) AND (Raw(I,8) OR Raw(I,14)) THEN GOSUB Inputpb0
2718 GOTO Go
2724 !
2730 Inputpb0: ! Enter initial-Pb ratios for age-calculations
2736 DATA " INITIAL-Pb ISOTOPE RATIOS: ","(Errors are absolute, not %)","","      206/204","       error"
       ,"      207/204","       error"
2742 DATA "","      208/204","       error","","      206/204 - 207/204","      error-correlation","",(Stacey
     -Kramers Model-Age?),&
2748 DATA "","","","18.70","0","","15.63","0","","38.63","0","","","0.9","",?,""
2754 DATA 0,0,0,0,0,0,9,1E5,0,1E4,0,0,9,1E4,0,1E3,0,0,25,1E4,0,1E3,0,0,0,0,-1,1,0,0,-1,-1,0,0
2760 DATA 0,0,0,1,1,0,1,1,0,1,1,0,0,1,0,1,0
2766 RESTORE 2736
2772 REDIM Prompt$(17),Response$(17),Range(17,2),Use(17),Nval(17)
2778 READ Prompt$(*),Response$(*),Range(*),Use(*)
2784 !
2790 Form(Lr6$(*),16,10)
2796 ON ERROR GOTO 2892
2802 Init_t=VAL(Response$(16))
2808 OFF ERROR
2814 IF Init_t)-1000 AND Init_t(5000 THEN ! Use S-K values for initial-Pb
2820   CALL Stacey_kramers(Init_t,Init64,Init74,Init84)
2826   Response$(4)=VAL$(Init64)
2832   Response$(5)="0"
2838   Response$(7)=VAL$(Init74)
2844   Response$(8)="0"
2850   Response$(10)=VAL$(Init84)
2856   Response$(11)="0"
2862   Response$(14)="0"
2868   Response$(16)="("&VAL$(Init_t)&")"
2874 END IF
2880 GOTO 2790
2886 !
2892 OFF ERROR
2898 IF NOT Escape AND SUM(Nval) THEN
2904   MAT Lr6$= Response$
2910   Init64=Nval(4)
2916   Init64err=Nval(5)
2922   Init74=Nval(7)
2928   Init74err=Nval(8)
2934   Init84=Nval(10)
2940   Init84err=Nval(11)
2946   Init6474_rho=Nval(14)
2952 ELSE
2958   DATA 0,0,0,0,0,0,0
2964   RESTORE 2958
```

```
2970   READ Init64,Init64err,Init74,Init74err,Init84,Init84err,Init6474_rho
2976 END IF
2982 RETURN
2988  !
2994  !
3000  ! *************** Printout Raw Data for This Sample ********************
3006  !
3012 Go:IF Pb205_spiked AND Raw(I,5)=0 AND NOT Kybrd THEN
3018   PRINT USING "2/,K,2/";"****** MUST HAVE A SPIKE-WEIGHT DEFINED FOR SAMPLE "&Name$(I)&" ******"
3024   GOTO Done
3030 END IF
3036 Ppmpb=0
3042 Ppmu=0
3048 Ppmth=0
3054 IF Kybrd THEN CALL Clear
3060 MAT Pbraw$= (" --")
3066 FOR J=8 TO 19
3072   IF Raw(I,J) THEN Pbraw$(J)=VAL$(Raw(I,J))
3078 NEXT J
3084 IF Printer THEN
3090   PRINTER IS CRT
3096   PRINT VAL$(I)&":  "&Trialname$
3102   DISP "Now reducing data for "&FNUn$(Trialname$)&"..."
3108   PRINTER IS 701
3114   PRINT CHR$(27)&"&k0S"  ! 80 characters/line
3120   PRINT RPT$("-",80)
3126 END IF
3132 PRINT USING "K,3X,K,/";"SAMPLE:",Trialname$
3138 IF Raw(I,8)+Raw(I,10)+Raw(I,12)+Raw(I,16)+Raw(I,18) THEN PRINT USING "11X,K,8X,K,8X,K";"206/204   %err","
     206/207   %err","206/208   %err"
3144 IF Printer THEN PRINT
3150 IF NOT Pb205_spiked THEN
3156   IF Raw(I,8) AND Raw(I,10) THEN
3162     PRINT "UNSPKD";TAB(12);Pbraw$(8);TAB(22);Pbraw$(9);TAB(34);Pbraw$(10);TAB(44);Pbraw$(11);TAB(56);Pbra
     w$(12);TAB(66);Pbraw$(13)
3168   END IF
3174 END IF
3180 IF (Pb205_spiked AND Raw(I,14) AND Raw(I,16)) OR (NOT Pb205_spiked AND Raw(I,18)) THEN PRINT "SPIKED";
3186 IF Pb205_spiked AND Raw(I,14) AND Raw(I,16) THEN
3192   PRINT TAB(12);Pbraw$(14);TAB(22);Pbraw$(15);TAB(34);Pbraw$(16);TAB(44);Pbraw$(17);TAB(56);Pbraw$(18);TA
     B(66);Pbraw$(19)
3198 END IF
3204 IF NOT Pb205_spiked AND Raw(I,18) THEN
3210   PRINT TAB(12);Pbraw$(14);TAB(22);Pbraw$(15);TAB(34);Pbraw$(16);TAB(44);Pbraw$(17);TAB(56);Pbraw$(18);TA
     B(66);Pbraw$(19)
3216 END IF
3222 IF Raw(I,5) THEN
3228   PRINT "SPIKE";TAB(10);Spike64;TAB(32);Spike67;TAB(54);Spike68
3234   IF Printer THEN PRINT
3240 END IF
3246 IF Pb205_spiked THEN
3252   PRINT "SPIKED-SAMPLE 206/205 =";Raw(I,8);FNEr$(Raw(I,9)),"SPIKE 206/205 =";Spike65
3258   IF Printer THEN PRINT
3264 END IF
3270 IMAGE "BLANK:  6/4=",DD.3D,"+/-",D.DD,5X,"7/4=",DD.3D,"+/-",D.DD,5X,"8/4=",DD.3D,"+/-",D.DD
3276 IMAGE 3D.5D," G ",10A," spiked, ",D.4DE,"  +/-",DD.DD,"% moles ",3D,"/G"
3282 IF Raw(I,5) THEN
3288   PRINT USING 3270;Blank64,Blank64err,Blank74,Blank74err,Blank84,Blank84err
3294   IF Printer THEN PRINT
3300 END IF
3306 S1$=Pbspike$
3312 IF Pb205_spiked THEN
3318   S2$=Pbspike$
3324   S3$=Pbspike$
```

```
3330 ELSE
3336   S1$=Pbspike$
3342   S3$=Th230$
3348   S2$=Uspike$
3354 END IF
3360 IF Raw(I,5)+Raw(I,6)+Raw(I,8)=0 THEN
3366   Bad_input("***** MUST BE SPIKED FOR AT LEAST ONE OF Pb OR U SPIKES *****")
3372   GOTO Done
3378 END IF
3384 IF Raw(I,5) AND NOT Pb205_spiked THEN PRINT USING 3276;Raw(I,5),S1$,Spike208pg,Pbspk_conc_perr,208
3390 IF Raw(I,5) AND Pb205_spiked THEN PRINT USING 3276;Raw(I,5),S1$,Spike205pg,Pbspk_conc_perr,205
3396 IF Raw(I,6) AND NOT U233_spiked THEN PRINT USING 3276;Raw(I,6),S2$,Spike235pg,Spike235pg_perr,235
3402 IF Raw(I,6) AND U233_spiked THEN PRINT USING 3276;Raw(I,6),S2$,Spike233pg,Spike233pg_perr,233
3408 IF Raw(I,7) THEN PRINT USING 3276;Raw(I,7),S3$,Spike230pg,Spike230pg_perr,230
3414 !
3420 IF Pb205_spiked OR (Raw(I,1)<>1 OR Raw(I,2)<>1 OR Raw(I,3) OR Raw(I,4)<>1) THEN
3426   IF NOT Pb205_spiked THEN
3432     IF Printer THEN PRINT
3438     PRINT TAB(6);"SAMPLE WT.";TAB(21);"TOTAL-AL.";TAB(34);"Pb-UNSPKD AL.";TAB(51);"Pb-SPKD AL."
3444   ELSE
3450     IF Printer THEN PRINT
3456     PRINT "SAMPLE WEIGHT = ";
3462   END IF
3468   IF NOT Pb205_spiked THEN PRINT TAB(6);Raw(I,1);TAB(21);Raw(I,2);TAB(35);Raw(I,3);TAB(51);Raw(I,4)
3474   IF Pb205_spiked THEN PRINT Raw(I,1)*1000;" milligrams"
3480 END IF
3486 !
3492 PRINT RPT$("-",80)
3498 IF Raw(I,1)+Raw(I,8)=0 THEN
3504   Bad_input("????? NO SAMPLE-WEIGHT FOR THIS SAMPLE ?????")
3510   GOTO Done
3516 END IF
3522 IF Raw(I,8)=0 AND (Raw(I,2)=0 OR Raw(I,4)=0) THEN
3528   Bad_input("***** NEED VALUES FOR TOTAL AND SPIKED ALIQUOT-WEIGHTS *****")
3534   GOTO Done
3540 END IF
3546 !
3552 !
3558 ! ********************* Start Calculations for this Sample *************
3564 !
3570 Start_calc:Pbspkd_al_equiv=Raw(I,4)*Raw(I,1)/Raw(I,2)  ! grams of solid-sample equivalent in Pb-spiked al
     iquot
3576 IF Raw(I,8)=0 AND (Raw(I,5)=0 OR (Pb205_spiked=0)*(Raw(I,12)=0) AND (Raw(I,18)=0)) OR (Pb205_spiked AND R
     aw(I,8)=0) THEN U_th_conc
3582 !
3588 FOR J=1 TO 40               ! zero the appropriate row in Red(i,j)
3594   Red(I,J)=0
3600 NEXT J
3606 IF NOT Pb205_spiked THEN    ! Raw 206/204
3612   Red(I,7)=Raw(I,8)
3618 ELSE
3624   Red(I,7)=Raw(I,14)
3630 END IF
3636 Red(I,1)=Raw(I,1) ! sample-weight
3642 Blank64perr=100*Blank64err/Blank64
3648 Blank74perr=100*Blank74err/Blank74
3654 Blank84perr=100*Blank84err/Blank84
3660 Init64perr=100*Init64err/(Init64+(Init64=0))
3666 Init74perr=100*Init74err/(Init74+(Init74=0))
3672 Init84perr=100*Init84err/(Init84+(Init84=0))
3678 !
3684 ! Test to see if Pb-data should be reduced using 206/208 ratios only, or with both 206/207 & 206/208 rat
     ios
3690 IF NOT Pb205_spiked AND ABS(Raw(I,10)-Raw(I,16))(2*SQR(2*Pbdisc_err^2+(Raw(I,11)*Raw(I,10))^2+(Raw(I,17)*
     Raw(I,18))^2)/100 THEN
3696   Pb68_only=1
```

```
3702 ELSE
3708   Pb68_only=0
3714 END IF
3720 IF Raw(I,16)=0 OR Raw(I,8)<22 THEN Pb68_only=1
3726  ! If either 206/204<22 or the difference between the unspiked 6/7 & spiked 6/7 is not statistically sign
     ificant, use only the 6/8 ratios
3732 IF Raw(I,6)=0 OR Raw(I,10)=0 THEN
3738   Nocomp=1
3744 ELSE
3750   Nocomp=0
3756 END IF
3762  !
3768  ! <<<<<<<<<< Correct Pb-isotope ratios for mass-discrimination >>>>>>>>>>
3774 IF Pb205_spiked THEN
3780   Dccorr_spkd65=Raw(I,8)*(1+Pbdisc/100)
3786 ELSE
3792   Dccorr_unsp64=Raw(I,8)*(1+2*Pbdisc/100)
3798 END IF
3804 Dccorr_unsp67=Raw(I,10)*(1-Pbdisc/100)
3810 IF Raw(I,8) AND Raw(I,10) THEN
3816   Dccorr_unsp68=Raw(I,12)*(1-2*Pbdisc/100)
3822 ELSE
3828   Dccorr_unsp68=Raw(I,12)
3834 END IF
3840 IF Raw(I,5) THEN GOTO 3906
3846  !
3852  ! only Pb-comp data, so just correct for mass-discr.
3858 Red(I,8)=Dccorr_unsp64
3864 Red(I,26)=DROUND(SQR(Raw(I,9)^2+4*Pbdisc_err^2),3)
3870 Red(I,27)=DROUND(SQR(Raw(I,9)^2+Raw(I,11)^2+9*Pbdisc_err^2),3)
3876 Red(I,28)=DROUND(SQR(Raw(I,9)^2+Raw(I,13)^2+16*Pbdisc_err^2),3)
3882 Red(I,29)=(Raw(I,9)^2+6*Pbdisc_err^2)/(Red(I,26)*Red(I,27))
3888 Red(I,30)=(Raw(I,9)^2+8*Pbdisc_err^2)/(Red(I,26)*Red(I,28))
3894 Pvar_67=0
3900  !
3906 Dccorr_spkd68=Raw(I,18)*(1-2*Pbdisc/100)
3912 Dccorr_spkd64=Raw(I,14)*(1+2*Pbdisc/100)
3918 Dccorr_spkd67=Raw(I,16)*(1-Pbdisc/100)
3924  !
3930  ! <<<<<<<<<< Calculate blank and spike ratios & abundances >>>>>>>>>>>>>>>>
3936 Blank67=Blank64/Blank74    ! Blank-Pb 6/7, 6/8, amount in nanograms
3942 Blank68=Blank64/Blank84
3948 Pbblank_ng=Raw(I,24)
3954 Pbunsp_al_equiv=Raw(I,3)*Raw(I,1)*(Raw(I,8)*Raw(I,10)*Raw(I,12)<>0)/Raw(I,2)    ! equivalent solid-sample
     weight, in grams, for Pb-unspiked aliquot
3960 Blank_mf204=1/(1+Blank64+Blank74+Blank84)   ! Mole-fraction 204 in Pb blank
3966 IF Init64=0 THEN                           ! Mole-fraction 204 for "common-Pb"
3972   Cpb_mf204=Blank_mf204
3978 ELSE
3984   Cpb_mf204=1/(Init64+Init74+Init84+1)
3990 END IF
3996 Atwt_blankpb=(Aw204+Aw206*Blank64+Aw207*Blank74+Aw208*Blank84)/(1+Blank64+Blank74+Blank84)    ! atomic we
     ight of blank-Pb
4002 IF Init64 THEN
4008   Atwt_cpb=(Aw204+Aw206*Init64+Aw207*Init74+Aw208*Init84)/(1+Init64+Init74+Init84)
4014 ELSE
4020   Atwt_cpb=Atwt_blankpb
4026 END IF
4032 !
4038 Pbcalc:Blank204=Pbblank_ng*Blank_mf204/Atwt_blankpb/1.E+9 ! Moles blank-204
4044 Blank206=Blank64*Blank204       ! Moles blank 206,207,208
4050 Blank207=Blank206/Blank67
4056 Blank208=Blank206/Blank68
4062 IF Pb205_spiked THEN Calc_205spkd_al
```

```
4068  !
4074  ! ((((((( [Pb] calculation for Pb-208 or Pb-206 spiked aliquot ))))))))
4080 Spike208=Spike208pg*Raw(I,5)    ! Moles spike 208,206,207,204
4086 Spike206=Spike208*Spike68
4092 Spike207=Spike206/Spike67
4098 Spike204=Spike206/Spike64
4104 Corr64=Dccorr_unsp64           ! Trial blank-corr. 6/4,6/7,6/8 of sample
4110 Corr67=Dccorr_unsp67
4116 Corr68=Dccorr_unsp68
4122 IF Raw(I,8)=0 OR Raw(I,10)=0 OR Pb68_only=1 THEN Pb_206208_only
4128  !
4134  !
4140  ! (((( Calculate [Pb] using both 206/207 and 206/208 of both Pb-spiked & Pb-unspiked aliquots ))))))
4146 REPEAT
4152   Numer=(Dccorr_spkd67*Spike207-Spike206)/(1-Dccorr_spkd67/Corr67)-(Dccorr_spkd68*Spike208-Spike206)/(1-D
       ccorr_spkd68/Corr68)
4158   Denom=(Dccorr_spkd68/Blank68-1)/(1-Dccorr_spkd68/Corr68)-(Dccorr_spkd67/Blank67-1)/(1-Dccorr_spkd67/Cor
       r67)
4164   Pbspkd_blank206=Numer/Denom  ! Moles blank-206 in spiked-aliquot required to explain the difference in
       unspiked & spiked 206/207 ratios
4170   Pb206_compal=(Dccorr_spkd68*(Pbspkd_blank206/Blank68+Spike208)-Spike206-Pbspkd_blank206)/(1-Dccorr_spkd
       68/Corr68)*Pbunsp_al_equiv/Pbspkd_al_equiv
4176  ! moles sample Pb-206 in Pb-unspiked aliquot
4182   Test64=Corr64
4188   GOSUB Subtract_blank
4194   IF Corr64(0 THEN Blank_too_high
4200 UNTIL ABS(Corr64-Test64)/Test64/1.E+9     ! 6/4 Convergence?
4206 !
4212 Ng_blnk_pbspkd=Atwt_blankpb*1.E+9*Pbspkd_blank206/Blank64/Blank_mf204  ! Ng_blnk_Pbspkd is nanograms blan
     k-Pb in Pb-spiked aliquot
4218 GOTO Pberrors
4224  !
4230 Subtract_blank:      ! Remove blank-Pb contribution to observed ratios
4236 Corr64=Pb206_compal/((Pb206_compal+Blank206)/Dccorr_unsp64-Blank204)
4242 Corr67=Pb206_compal/((Pb206_compal+Blank206)/Dccorr_unsp67-Blank207)
4248 Corr68=Pb206_compal/((Pb206_compal+Blank206)/Dccorr_unsp68-Blank208)
4254 RETURN
4260  !
4266 Blank_too_high:PRINT USING "/,K,/";"*** Pb-BLANK MUST BE ("&VAL$(DROUND(Raw(I,24),3))&" nG ***"
4272 Clunk
4278 Pbblank_ng=Pbblank_ng*2/3  !  Reduce blank-amount by 1/3
4284 Raw(I,24)=Raw(I,24)*2/3
4290 GOTO Pbcalc
4296  !
4302 Pb_206208_only:      ! (((( Calculate [Pb] using only 206/208 ratios ))))
4308 IF Nocomp AND Raw(I,12)=0 THEN
4314   PRINT USING "/,K,/,/";"**** ESTIMATED UNSPIKED 206/208 MUST BE ENTERED ****"
4320   Clunk
4326   GOTO Done
4332 END IF
4338 IF Nocomp THEN
4344   Raw(I,9)=Raw(I,15)
4350   Raw(I,11)=Raw(I,17)
4356 END IF
4362 Corr68=ABS(Dccorr_unsp68)
4368  ! Pb206_compal=Estimated moles of sample 206 in Pb-unspiked aliquot (or spiked aliquot if there is no un
     spiked aliquot)
4374  !
4380 REPEAT
4386   Pb206_compal=(Pbunsp_al_equiv/Pbspkd_al_equiv+(Pbunsp_al_equiv=0))*(Dccorr_spkd68*(Spike208+Blank208)-S
       pike206-Blank206)/(1-Dccorr_spkd68/Corr68)
4392   Test68=Corr68
4398   IF Nocomp THEN 4446
4404 !
4410   GOSUB Subtract_blank
```

```
4386   Pb206_compal=(Pbunsp_al_equiv/Pbspkd_al_equiv*(Pbunsp_al_equiv=0))*(Dccorr_spkd68*(Spike208+Blank208)-S
       pike206-Blank206)/(1-Dccorr_spkd68/Corr68)
4392   Test68=Corr68
4398   IF Nocomp THEN 4446
4404 !
4410   GOSUB Subtract_blank
4416 UNTIL ABS(Test68/Corr68-1)<1/1.E+9  ! Convergence test on 6/8
4422 !
4428 IF Corr64<=0 THEN Blank_too_high
4434 GOTO Pberrors
4440 !
4446 Corr67=Pb206_compal/((Pb206_compal+Blank206+Spike206)/Dccorr_spkd67-Blank207-Spike207)    ! Corrected sam
       ple 206/207 (no Pb-unspiked data)
4452 Corr64=Pb206_compal/((Pb206_compal+Blank206+Spike206)/Dccorr_spkd64-Blank204-Spike204)    ! same for 206/
       204
4458 GOTO 4428
4464 !
4470 Calc_205spkd_al:                  ! calculate [Pb] for Pb-205 spiked aliquot
4476 Sample206=Spike205pg*Raw(I,5)     ! Pb-205 spiked concentration calculation - [206] in Pbspiked-al
4482 Pb206_compal=Sample206*(Dccorr_spkd65-Spike65)-Blank206
4488 Corr68=Pb206_compal/(Sample206*(Dccorr_spkd65/Dccorr_spkd68-Spike65/Spike68)-Blank208)    ! BLANK-CORR 6/
       8
4494 Corr67=Pb206_compal/(Sample206*(Dccorr_spkd65/Dccorr_spkd67-Spike65/Spike67)-Blank207)    !   "    "  6/
       7
4500 Corr64=Pb206_compal/(Sample206*(Dccorr_spkd65/Dccorr_spkd64-Spike65/Spike64)-Blank204)    !   "    "  6/
       4
4506 IF Corr64<=0 THEN Blank_too_high
4512 Pvar_206=(Dccorr_spkd65*Sample206/Pb206_compal*Raw(I,9))^2+(Blank206/Pb206_compal*Pbblank_perr)^2+Pbspk_c
       onc_perr^2     ! VARZ for Pb-206 concentration
4518 Raw(I,9)=Raw(I,15)
4524 Raw(I,11)=Raw(I,17)
4530 Raw(I,13)=Raw(I,19)
4536 !
4542 ! <<<<< Error & error-correlation calculation for Pb ratios & concentrations >>>>>
4548 Pberrors:D=Blank206/Pb206_compal
4554 F=Blank207*Corr67/Pb206_compal
4560 E=Blank204*Corr64/Pb206_compal
4566 G=Blank208*Corr68/Pb206_compal
4572 ! D=blank-206/sample-206       E=blank-204/sample-204
4578 ! F=blank-207/sample-207       G=blank-208/sample-208
4584 Pvar_spkd68=Raw(I,13)^2+4*Pbdisc_err^2    !       VARZ of spiked 6/8
4590 Pvar_unspkd68=Raw(I,19)^2+4*Pbdisc_err^2  !       "    "  unspiked "
4596 IF Pb205_spiked THEN GOTO 4662
4602 Total208=Spike208+Blank208
4608 Total68=(Spike206+Blank206)/Total208
4614 Var_blank206=(.01*Pbblank_perr*Blank206)^2    ! VAR of blank 206 amount
4620 Var_blank68=((Blank64err/Blank64)^2+(Blank84err/Blank84)^2-2*Blank6484_rho*Blank64err/Blank64*Blank84err/
       Blank84)*Blank68^2     ! VAR of blank 206/208
4626 V6=((Corr68-Total68)*Dccorr_spkd68/((Corr68-Dccorr_spkd68)*(Dccorr_spkd68-Total68)))^2*Pvar_spkd68+(Dccor
       r_spkd68/((Corr68-Dccorr_spkd68))^2*Pvar_unspkd68
4632 ! V6 is [206] VARZ, not including contr. from blank-Pb or Spike uncertainties
4638 A=(Corr68/(Corr68-Dccorr_spkd68))^2
4644 Vb=A*(Var_blank206/Total208^2+(Blank206/Total208^2/Blank68)^2*(Var_blank206+Blank206^2*Var_blank68))*1000
       0/Pb206_compal*Spike208^2
4650 ! Vb is [206] VARZ contribution from blank-Pb uncertainties
4656 Pvar_206=V6+Vb+Pbspk_conc_perr^2    !   VARZ of Pb-206 concentration
4662 V64=Raw(I,9)^2      !       "    of raw 6/4  (uncorr. for blank or discrimination)
4668 V67=Raw(I,11)^2     !       "    "   "  6/7      "
4674 V68=Raw(I,13)^2     !       "    "   "  6/8      "
4680 Pvar_64=(1+E)^2*V64+(E*Blank64perr)^2+(D-E)^2*Pvar_206+((E-D)*Pbblank_perr)^2+((2+2*E)*Pbdisc_err)^2    !
       VARZ of blank & discrim.-corr. sample 206/204
4686 A=(1+E)^2*V64+(1+F)^2*V67+((F-E)*Blank64perr)^2+(F*Blank74perr)^2+(F-E)^2*Pvar_206
4692 Pvar_74=A+((E-F)*Pbblank_perr)^2-2*F*(F-E)*Blank6474_rho*Blank64perr*Blank74perr+((3+2*E+F)*Pbdisc_err)^2
       ! ditto, 207/204
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4698 A=(1+E)^2*V64+(1+G)^2*V68+((E-G)*Blank64perr)^2+(G*Blank84perr)^2+(E-G)^2*Pvar_206
4704 Pvar_84=A+((E-G)*Pbblank_perr)^2-2*G*(G-E)*Blank64perr*Blank84perr*Blank6484_rho+((4+2*E+2*G)*Pbdisc_err)
     ^2    ! ditto, 208/204
4710 A=(1+E)^2*V64-E*(F-E)*Blank64perr^2+(D-E)*(F-E)*Pvar_206+(E-D)*(E-F)*Pbblank_perr^2
4716 Rho_betaalpha=(A+(3+2*E+F)*(2+2*E)*Pbdisc_err^2+E*F*Blank6474_rho*Blank64perr*Blank74perr)/SQR(Pvar_64*Pv
     ar_74)! Rho for true sample 207/204-206/204
4722 A=(1+E)^2*V64+E*(E-G)*Blank64perr^2+(D-E)*(G-E)*Pvar_206+(D-E)*(G-E)*Pbblank_perr^2
4728 Rho_gammaalpha=(A+(2+2*E)*(4+2*E+2*G)*Pbdisc_err^2+E*G*Blank64perr*Blank84perr*Blank6484_rho)/SQR(Pvar_64
     *Pvar_84)
4734 Molespg_206=Pb206_compal/FNAliq(Pbunsp_al_equiv,Pbspkd_al_equiv)    !  moles 206 per gram
4740 P=Molespg_206
4746 Pbgrams_pergram=Aw206*P+Aw207*P/Corr67+Aw208*P/Corr68+Aw204*P/Corr64
4752 Cpb_ppm=Atwt_cpb*1.E+6*Pb206_compal/(Cpb_mf204*Corr64*FNAliq(Pbunsp_al_equiv,Pbspkd_al_equiv))  ! ppm com
     mon Pb
4758 Pvar_67=Pvar_64+Pvar_74-2*Rho_betaalpha*SQR(Pvar_64*Pvar_74)     ! 6/7 VARX
4764 Pvar_68=Pvar_64+Pvar_84-2*Rho_gammaalpha*SQR(Pvar_64*Pvar_84)     ! 6/8 VARX
4770 Red(I,26)=DROUND(SQR(Pvar_64),3)      ! 6/4 err, to 3 signif. figs
4776 Red(I,27)=DROUND(SQR(Pvar_74),3)      ! 7/4  "   "  "    "
4782 Red(I,28)=DROUND(SQR(Pvar_84),3)      ! 8/4  "   "  "    "
4788 Red(I,29)=Rho_betaalpha    !          Error-correlation between 6/4 & 7/4
4794 Red(I,25)=DROUND(SQR(Pvar_206),3)     ! [206] err, to 3 signif. figs
4800 Red(I,24)=DROUND(SQR(Pvar_206+Pvar_64),3)     ! ditto [204] err
4806 Red(I,30)=Rho_gammaalpha    ! Error-correlation between 6/4 & 8/4
4812 Ppmpb=1.E+6*Pbgrams_pergram
4818 Red(I,4)=Ppmpb                ! ppm Pb
4824 Red(I,8)=Corr64    ! Blank- & discrimination-corrected 206/204
4830 Red(I,5)=DROUND(Cpb_ppm,4)    ! ppm common-Pb, rounded to 4 signif. figs
4836 Red(I,9)=Corr64/Corr67    ! Blank & discrimination-corrected 207/204
4842 Red(I,10)=Corr64/Corr68    ! ditto, 206/208
4848 Red(I,6)=1.E+9*Molespg_206  ! nanomoles Pb-206 per gram
4854 Print_pb:PRINT TAB(9);"Pb-Unspiked Aliquot, Corrected for ";VAL$(DROUND(Raw(I,24),2));"+/-";VAL$(DROUND(.
     01*Pbblank_perr*Raw(I,24),2));" nG Pb-Blank, "
4860 PRINT TAB(15);"and ";VAL$(Pbdisc);"+/-";VAL$(Pbdisc_err);" %/a.m.u. Mass-Discrimination"
4866 IF Printer THEN PRINT
4872 PRINT "  206/207";TAB(18);"206/208";TAB(32);"206/204";TAB(47);"207/204";TAB(62);"208/204"
4878 PRINT TAB(2);DROUND(Corr67,5);TAB(17);DROUND(Corr68,5);TAB(31);DROUND(Red(I,8),5);TAB(46);DROUND(Red(I,9)
     ,5);TAB(61);DROUND(Red(I,10),5)
4884 PRINT " "&FNErr$(Pvar_67);TAB(17);FNErr$(Pvar_68);TAB(31);FNEr$(Red(I,26));
4890 PRINT TAB(46);FNEr$(Red(I,27));TAB(61);FNEr$(Red(I,28))
4896 IF Printer THEN PRINT
4902 PRINT " Error-Correls:  207/204-206/204=";VAL$(DROUND(Red(I,29),6));"     208/204-206/204=";VAL$(DROUND(R
     ed(I,30),6))
4908 PRINT
4914 IF Raw(I,5)=0 THEN Done
4920 IMAGE 26X,"Moles Pb Per Gram:",/,4X,"206",12X,"207",12X,"208",12X,"204",11X,"TOTAL",/,5(MD.5DE,3X)
4926 P=Molespg_206
4932 PRINT USING 4920:P,P/Corr67,P/Corr68,P/Corr64,P+P/Corr67+P/Corr68+P/Corr64
4938 PRINT " "&FNEr$(Red(I,25))
4944 IF NOT Pb68_only OR Pb205_spiked THEN
4950   IF Printer THEN PRINT
4956   PRINT DROUND(1000*Cpb_ppm*FNAliq(Pbunsp_al_equiv,Pbspkd_al_equiv),2);" nG Common-Pb in Unspkd Al. ----
       ("&VAL$(DROUND(Cpb_ppm,3))&" PPM)"
4962 END IF
4968 IF Printer THEN PRINT
4974 PRINT FNL$(Pbgrams_pergram);" Total Pb =";DROUND(FNM(Pbgrams_pergram),5);
4980 IF Pb68_only()1 AND NOT Pb205_spiked THEN PRINT "       Pb-Spiked Aliquot Blank =";DROUND(Ng_blnk_pbspkd,
     2);"nG";
4986 PRINT
4992  !
4998  ! ***************** CALCULATE U,Th CONCENTRATIONS &ERRORS *****************
5004 U_th_conc:IF Raw(I,6)*Raw(I,20)=0 THEN Done ! If not spiked for U-Th or no ratios
5010 Uspkd_equiv=Pbspkd_al_equiv*(NOT Total_uspiked)+Raw(I,1)*Total_uspiked  ! Wt of sample spiked with U & Th
       spike
5016 Fract_corr20=Raw(I,22)*(1+.02*Thdisc)
```

```
5022 Blank238=Raw(I,25)/238.029*(137.88/138.88)/1.E+9 ! Moles blank-U238
5028 IF U233_spiked THEN
5034   IF Have_samspk THEN ! Data already calculated for sample/spike ratio
5040     Moles238_spkdal=Raw(I,20)*Raw(I,6)*Spike233pg-Blank238
5046   ELSE ! Must calculate from 233/236 & 233/238 ratios
5052     Ufract=(Raw(I,27)/Spike233236-1)/3 ! Fractionation per amu from 233/236
5058     True233238=Raw(I,20)/(1+5*Ufract)  ! Fractionation-corrected (233/238)m
5064     Moles238_spkdal=Spike233pg*Raw(I,6)*(1/True233238-Spike238233)-Blank238
5070     Sample238perr=SQR(Spike233perr^2+(5/3*Obs_233236perr)^2+(Blank238perr*Blank238/Moles238_spkdal)^2)
5076   END IF
5082 ELSE
5088   Fract_corr85=Raw(I,20)*(1+.03*Udisc)
5094   Moles238_spkdal=Raw(I,6)*Spike235pg*(Fract_corr85-Spike238235)/(1-Fract_corr85/Nat_uratio)-Blank238   !
         [238] in U-spiked aliquot
5100 END IF
5106 Ng_u_spkdal=Moles238_spkdal*(1+1/Nat_uratio)*Atwt_u*1.E+9
5112 !
5118 ! Th in U/Th-spiked aliquot
5124 Moles232_spkdal=(Raw(I,7)()0)*((Raw(I,22)()0)*(Raw(I,7)*Spike230pg*(Fract_corr20-(Spike232230+(Spike23223
     0=0)))-Raw(I,26)/1.E+9/232))
5130 Ng_th_spkdal=Moles232_spkdal*Atwt_th*1.E+9
5136 Rad(I,3)=1.E+6*(Moles232_spkdal()0)*Atwt_th*Moles232_spkdal/Uspkd_equiv
5142 Ppmth=1.E+6*(Moles232_spkdal()0)*Atwt_th*Moles232_spkdal/Uspkd_equiv
5148 Rad(I,2)=1.E+6*Atwt_u*(Moles238_spkdal+Moles238_spkdal/Nat_uratio)/Uspkd_equiv
5154 Ppmu=1.E+6*Atwt_u*(Moles238_spkdal+Moles238_spkdal/Nat_uratio)/Uspkd_equiv
5160   ! Errors & error-correlations - U-Th concs & U-Th/Pb-204 ratios
5166 Pbspike_perr=Pbspk_conc_perr
5172 IF U233_spiked THEN
5178   IF Have_samspk THEN Pvar_u=Raw(I,21)^2+Spike233pg_perr^2
5184   IF NOT Have_samspk THEN Pvar_u=(5/3*Raw(I,28))^2+Raw(I,21)^2+Spike233pg_perr^2 ! approximate, for now.
5190 ELSE
5196   Pvar_u=(Nat_uratio/(Nat_uratio-Raw(I,20)))^2*Raw(I,21)^2+(3*Udisc_err)^2+Spike235pg_perr^2
5202 END IF
5208 Pvar_u=Pvar_u+(.01*Ublank_perr*Raw(I,25)/1.E+9/Ng_u_spkdal)^2 ! VAR% of [U]
5214 IF Ppmth=0 THEN
5220   Pvar_th=0
5226 ELSE
5232   Pvar_th=Raw(I,22)/(Raw(I,22)-1/(Spike232230+(Spike232230=0)))^2*Raw(I,24)^2+(2*Thdisc_err)^2+Spike230pg
       perr^2  ! Ditto, [Th]
5238   Pvar_th=Pvar_th+(.01*Thblank_perr*Raw(I,26)/1.E+9/Ng_th_spkdal)^2
5244 END IF
5250 IF Rad(I,4) AND Ppmu THEN
5256   Rad(I,21)=Moles232_spkdal*Corr64/Uspkd_equiv/Molespg_206  ! 232/204
5262   Pvar1_206=Pvar_206-Mixed_spike*Pbspk_conc_perr^2  ! Don't include spike-concentration uncertainty for P
       b/U ratios if a mixed Pb-U-Th spike
5268   Pvar1_u=Pvar_u-Mixed_spike*Spike235pg_perr^2      !   ditto
5274   Pvar1_th=Pvar_th-Mixed_spike*Spike230pg_perr^2    !  ditto
5280   Pvar_mu=V64*(1+E)^2+(E*Blank64perr)^2+Pvar1_206*(1+E)^2+(E*Pbblank_perr)^2+((2+2*E)*Pbdisc_err)^2+Pvar1
         _u                          ! var% in 238/204
5286   Rad(I,36)=DROUND(SQR(Pvar_mu),3)   ! %error in Mu
5292   A=V64*(1+E)^2+(E*Blank64perr)^2-(1+E)*(D-E)*Pvar1_206+E*(E-D)*Pbblank_perr^2
5298   Rad(I,38)=(A+2*(1+E)*Pbdisc_err^2)/SQR(Pvar_64*Pvar_mu)   ! error-correl. 206/204-238/204
5304   A=V64*(1+E)^2+E*(F-E)*Blank64perr^2-(1+E)*(F-E)*Pvar1_206+E*(E-F)*Pbblank_perr^2
5310   Rad(I,39)=(A+2*(3+2*E+F)*(1+E)*Pbdisc_err^2-E*F*Blank6474_rho*Blank64perr*Blank74perr)/SQR(Pvar_74*Pvar
       _mu)   ! error-correl. 207/204-235/204
5316   IF Ppmth THEN
5322     Pvar_th204=V64*(1+E)^2+(E*Blank64perr)^2+(1+E)^2*Pvar1_206+(E*Pbblank_perr)^2+((2+2*E)*Pbdisc_err)^2+
       Pvar1_th! var% in 232/204
5328     Rad(I,37)=DROUND(SQR(Pvar_th204),3) ! %error in 232/204
5334     A=(1+E)^2*V64+E*(G-E)*Blank64perr^2-(1+E)*(G-E)*Pvar1_206+E*(E-G)*Pbblank_perr^2
5340     Rad(I,40)=(A+(4+2*E+2*G)*(2+2*E)*Pbdisc_err^2-E*G*Blank6474_rho*Blank64perr*Blank84perr)/SQR(Pvar_th2
       04*Pvar_84) ! error-corr. 208/204-232/204
5346   END IF
5352   Rad(I,19)=Moles238_spkdal*Corr64/Uspkd_equiv/Molespg_206  ! 238/204
```

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5358   Mu=Moles238_spkdal*Corr64/Uspkd_equiv/Molespg_206
5364   Red(I,20)=Mu/Nat_uratio                                    ! 235/204
5370 END IF
5376 !
5382 PRINT RPT$("-",80)
5388 IF U233_spiked THEN
5394   PRINT "SAMPLE-238/SPIKE-233";
5400 ELSE
5406   PRINT "238/235";
5412 END IF
5418 PRINT " =";Raw(I,20);"+/-";Raw(I,21);"%";
5424 IF Ppmth THEN PRINT TAB(42);"232/230=";Raw(I,22);"+/-";Raw(I,23);"%";
5430 PRINT
5436 IF U233_spiked AND NOT Have_samspk THEN
5442   PRINT "233/236 =";Raw(I,27);"+/-";Raw(I,28);"%";TAB(40);"Fractionation =";VAL$(DROUND(100*Ufract,3));"%
       per mass-unit"
5448 END IF
5454 PRINT Raw(I,25);"nG U-Blank";
5460 IF Ppmth THEN PRINT "     ";Raw(I,26);"nG Th-Blank";
5466 PRINT USING "8X,3(K),/";"U-Th SPIKED-AL.= ",Raw(I,2)*Total_uspiked+Raw(I,4)*(NOT Total_uspiked)," Grams"
5472 IMAGE 24X,"238",12X,"235",12X,"232",/,"Moles Per Gram:",5X,2(MD.4DE,4X),X,K,/
5478 IF Ppmth THEN
5484   Is$=VAL$(DROUND(Moles232_spkdal/Uspkd_equiv,5))
5490 ELSE
5496   Is$="   ---"
5502 END IF
5508 PRINT USING 5472;Moles238_spkdal/Uspkd_equiv,Moles238_spkdal/Uspkd_equiv/Nat_uratio,Is$
5514 Red(I,22)=DROUND(SQR(Pvar_u),3)     ! %error in [U]
5520 PRINT TAB(4);DROUND(FNM(Ppmu/1.E+6),5);TAB(14);FNL$(Ppmu/1.E+6);TAB(18);"Uranium";TAB(32);"("&FNEr$(Red(I
       ,22))&")"
5526 IF Ppmth THEN
5532   Red(I,23)=DROUND(SQR(Pvar_th),3)   ! %error in [Th]
5538   PRINT TAB(4);DROUND(FNM(Ppmth/1.E+6),4);TAB(14);FNL$(Ppmth/1.E+6);TAB(18);"Thorium";TAB(32);"("&FNEr$(R
       ed(I,23))&")";
5544   IF Ppmu AND Ppmth THEN
5550     PRINT USING "12X,K,K";"Th/U=",DROUND(Ppmth/Ppmu,4)
5556   END IF
5562   IF Printer THEN PRINT
5568 END IF
5574 IF Ppmu AND Ppmpb THEN PRINT "238/204=";DROUND(Red(I,19),5),"    235/204=";DROUND(Red(I,20),5);TAB(51);"(
       "&FNEr$(Red(I,36))&")"
5580 IF Ppmth AND Ppmpb THEN PRINT "232/204=";DROUND(Red(I,21),4);TAB(51);"("&FNEr$(Red(I,37))&")"
5586 IF Printer THEN PRINT
5592 IMAGE "Rho(U/4-6/4)=",M.6D,15X,"Rho(U/4-7/4)=",M.6D,6X
5598 IMAGE "Rho(U/4-6/4)=",M.6D,8X,"Rho(U/4-7/4)=",M.6D,8X,"Rho(Th/4-8/4)=",M.6D
5604 IF Ppmpb AND Ppmth THEN PRINT USING 5598;Red(I,38),Red(I,39),Red(I,40)
5610 IF Ppmu AND Ppmpb AND Ppmth=0 THEN PRINT USING 5592;Red(I,38),Red(I,39)
5616 PRINT RPT$("-",80)
5622 IF NOT Init64 OR NOT Corr64 THEN Done
5628 !
5634 ! ******* Calculate radiogenic-Pb isotope ratios and errors ***************
5640 !
5646 !
5652 Rad206=Molespg_206*(Corr64-Init64)/Corr64
5658 Rad207=Molespg_206*(1/Corr67-Init74/Corr64)
5664 Rad208=Molespg_206*(1/Corr68-Init84/Corr64)
5670 Radsample_wt=FNAliq(Pbsmsp_al_equiv,Pbspkd_al_equiv)
5676 !
5682 ! D1=init-206/rad-206    D2=total-206/rad-206   D3=blank-206/rad-206
5688 ! E1=total-204/initial-204                      E2=blank-204/initial-204
5694 ! F1=init-207/rad-207    F2=total-207/rad-207   F3=blank-207/rad-207
5700 ! G1=init-208/rad-208    G2=total-208/rad-208   G3=blank-208/rad-208
5706 !
5712 D1=Pb206_compal*Init64/(Corr64*Rad206*Radsample_wt)
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5718 D2=(Pb206_compal+Blank206)/(Rad206*Radsample_wt)
5724 D3=Blank206/(Rad206*Radsample_wt)
5730 F1=Init74*Pb206_compal/(Corr64*Rad207*Radsample_wt)
5736 F2=(Pb206_compal/Corr67+Blank207)/(Rad207*Radsample_wt)
5742 F3=Blank207/(Rad207*Radsample_wt)
5748 E1=(Pb206_compal+Blank204*Corr64)/Pb206_compal
5754 E2=Corr64*Blank204/Pb206_compal
5760 G1=Init84*Pb206_compal/(Corr64*Rad208*Radsample_wt)
5766 G2=(Pb206_compal/Corr68+Blank208)/(Rad208*Radsample_wt)
5772 G3=Blank208/(Rad208*Radsample_wt)
5778 Pvar_208232=0
5784 V64=Raw(I,9)^2+(2*Pbdisc_err)^2 ! Zvar for raw 6/4,6/7,6/8, incl mass-disc. error
5790 V67=Raw(I,11)^2+Pbdisc_err^2
5796 V68=Raw(I,13)^2+(2*Pbdisc_err)^2
5802 Pvar_206238=(D1*E1)^2*V64+(D1*E2*Blank64perr)^2+(D1*Init64perr)^2+(D2-D1*E1)^2*Pvar1_206+((D3-D1*E2)*Pbbl
     ank_perr)^2+Pvar1_u
5808 Red(I,31)=DROUND(SQR(Pvar_206238),3)     ! Zerror in radiogenic 206/238
5814 A=(F1*E1)^2*V64+((F3-F1*E2)*Blank64perr)^2+(F1*Init74perr)^2+F2^2*V67+(F3*Blank74perr)^2+(F2-F1*E1)^2*Pva
     r1_206
5820 Pvar_207235=A+((F3-F1*E2)*Pbblank_perr)^2+Pvar1_u-2*F3*(F3-F1*E2)*Blank6474_rho*Blank64perr*Blank74perr
5826 Red(I,32)=DROUND(SQR(Pvar_207235),3)     ! Zerror in radiogenic 207/235
5832 IF Raw(I,7)=0 OR Raw(I,22)=0 THEN GOTO 5856 ! if not spiked with Th or no 232/230 data
5838 A=(G1*E1)^2*V64+((G3-G1*E2)*Blank64perr)^2+(G1*Init84perr)^2+G2^2*V68+(G3*Blank84perr)^2+(G2-G1*E1)^2*Pva
     r1_206
5844 Pvar_208232=A+((G3-G1*E2)*Pbblank_perr)^2+Pvar1_th-2*G3*(G3-G1*E2)*Blank6484_rho*Blank64perr*Blank84perr
5850 Red(I,35)=DROUND(SQR(Pvar_208232),3)     ! Zerror in 208/232
5856 A=D1*F1*E1^2*V64-D1*E2*(F3-F1*E2)*Blank64perr^2+(D2-D1*E1)*(F2-F1*E1)*Pvar1_206+(D3-D1*E2)*(F3-F1*E2)*Pbb
     lank_perr^2
5862 Cov=A+Pvar1_u+D1*F1*Init6474_rho*Init64perr*Init74perr+D1*F3*E2*Blank6474_rho*Blank64perr*Blank74perr
     ! COV(2067238,207/235)/((206/238)*(207/235))
5868 Pvar_207206=Pvar_206238+Pvar_207235-2*Cov ! VARZ & Zerror in radiogenic 207/206
5874 Red(I,33)=DROUND(SQR(Pvar_207206),3)
5880 Red(I,34)=Cov/SQR(Pvar_206238*Pvar_207235) ! Error-correlation for 206/238-207/235
5886 Rad(I,11)=Rad206*Uspkd_equiv/Moles238_spkdal ! radiogenic 206/238,207/235
5892 Rad206238=Rad206*Uspkd_equiv/Moles238_spkdal
5898 Red(I,12)=Rad207*Uspkd_equiv*Nat_uratio/Moles238_spkdal
5904 Rad207235=Rad207*Uspkd_equiv*Nat_uratio/Moles238_spkdal
5910 Red(I,13)=Rad207/Rad206
5916 Rad207206=Rad207/Rad206
5922 IF Ppath THEN
5928   Red(I,14)=Uspkd_equiv*Rad208/Moles232_spkdal
5934   Rad208232=Uspkd_equiv*Rad208/Moles232_spkdal
5940 ELSE
5946   Red(I,14)=0
5952   Rad208232=0
5958 END IF
5964 !
5970 ! Pb/U AND Pb/Th APPARENT-AGES
5976 IF Rad206238)-1 THEN    ! Pb206/U238 age
5982   Red(I,15)=LOG(1+Rad206238)/Lambda238
5988 ELSE
5994   Red(I,15)=0
6000   Rad206238=0
6006 END IF
6012 IF Rad207235)-1 THEN    ! Pb207/U235 age
6018   Red(I,16)=LOG(1+Rad207235)/Lambda235
6024 ELSE
6030   Red(I,16)=0
6036   Rad207235=0
6042 END IF
6048 IF Rad208232)-1 AND Rad208232(.5 THEN    ! Pb208/Th232 age
6054   Red(I,18)=LOG(1+Rad208232)/Lambda232
6060 ELSE
6066   Red(I,18)=0
```

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6072   Rad208232=0
6078 END IF
6084  !
6090  ! Calculate 207/206 age
6096  !
6102 CALL Pb_pb_age(Rad207206,Age207206)
6108 Red(I,17)=Age207206
6114  !
6120  ! -------------------- Printout radiogenic-Pb results -------------------
6126 IMAGE "Radiogenic-Pb",8X,"206*",11X,"207*",11X,"208*",/,"Moles Per Gram:",3X,3(MD.4DE,5X)
6132 PRINT USING 6126;Rad206,Rad207,Rad208
6138 IF Printer THEN PRINT
6144 PRINT "Initial-Pb:   6/4=";VAL$(Init64);" +/- ";VAL$(Init64err);TAB(43);"7/4=";
6150 PRINT VAL$(Init74);" +/- ";VAL$(Init74err)
6156 PRINT TAB(15);"8/4=";VAL$(Init84);" +/- ";VAL$(Init84err);
6162 PRINT TAB(43);"RHO(6/4-7/4) =";Init6474_rho
6168 PRINT TAB(17);"206/238";TAB(33);"207/235";TAB(48);"207/206";
6174 IF Red(I,14) THEN
6180   PRINT TAB(62);"208/232"
6186 ELSE
6192   PRINT
6198 END IF
6204 PRINT "RATIOS:";TAB(15);DROUND(Rad206238,6);TAB(31);DROUND(Rad207235,6);TAB(47);DROUND(Rad207206,6);
6210 IF Red(I,14) THEN
6216   PRINT TAB(60);DROUND(Red(I,14),5)
6222 ELSE
6228   PRINT
6234 END IF
6240 PRINT "ERRORS:";TAB(17);VAL$(Red(I,31))&"%";TAB(33);VAL$(Red(I,32))&"%";TAB(48);VAL$(Red(I,33))&"%";
6246 IF Red(I,14) THEN
6252   PRINT TAB(62);VAL$(DROUND(Red(I,35),5))&"%"
6258 ELSE
6264   PRINT
6270 END IF
6276 PRINT "AGES (Ma):";TAB(16);DROUND(Red(I,15),5);TAB(32);DROUND(Red(I,16),5);TAB(47);DROUND(Red(I,17),5);
6282 IF Red(I,14) THEN
6288   PRINT TAB(61);DROUND(Red(I,18),5)
6294 ELSE
6300   PRINT
6306 END IF
6312 IF Printer THEN PRINT
6318 PRINT "Rho (207/235-206/238) =";DROUND(Red(I,34),6)
6324 IF Kybrd THEN Done
6330 Done:IF Printer THEN PRINT RPT$("*",80)
6336 DISP
6342 PRINTER IS CRT
6348  !
6354  ! ************************ END CALCULATIONS *******************************
6360  !IF Printer THEN PRINT USING "2/"  !#####
6366 IF Kybrd=0 THEN
6372   GOTO Nextsample
6378 ELSE
6384   Whoop
6390   PRINT USING "/,K,/";"PRESS"&FNCt$&"TO CONTINUE."
6396   PAUSE
6402 END IF
6408 Clear
6414 GOTO Choose
6420  !
6426 Printer_output:BEEP 440,.08
6432 Printer_ok=1
6438 ON TIMEOUT 7,.1 CALL Printer_timeout
6444 PRINTER IS 701
6450 PRINT
```

```
6456 IF Printer ok THEN
6462   OFF TIMEOUT
6468   Printer=1
6474   Crt=0
6480   PRINT CHR$(27)&"&k0S"  ! normal-size print
6486 END IF
6492 PRINTER IS CRT
6498 GOTO Choose
6504  !
6510 Crt_output:BEEP 440,.08
6516 Printer=0
6522 Crt=1
6528 GOTO Choose
6534  !
6540  !
6546 Changepb0:BEEP 440,.08
6552 GOSUB Inputpb0
6558 GOTO Choose
6564  !
6570 U_233:U233_spiked=1
6576 Pb205_spiked=0
6582 Transfer_labdat
6588 BEEP 440,.08
6594 GOTO Choose
6600 !
6606 U_235:U233_spiked=0
6612 Pb205_spiked=0
6618 Transfer_labdat
6624 BEEP 440,.08
6630 GOTO Choose
6636 !
6642 Pb_205:Pb205_spiked=1
6648 U233_spiked=(Pb205(12)<>0)
6654 BEEP 440,.08
6660 Transfer_labdat
6666 GOTO Choose
6672  !
6678 Pb_208:Pb205_spiked=0
6684 Transfer_labdat
6690 BEEP 440,.08
6696 GOTO Choose
6702  !
6708  !
6714 Datafile:OFF KBD
6720 OFF KEY
6726 Clear
6732 IF SUM(Raw0)=0 THEN
6738   Vcfile(Dfile,Raw0(*),Name$(*),Nsamples,Rawfile$,Escape)
6744   IF Escape THEN Choose
6750 END IF
6756 PRINT TABXY(1,3);FNH$("DATA REDUCTION FROM A RAW-DATA DATAFILE:")
6762 PRINT TABXY(1,5);"(Raw-data file now in memory is "&FNH$(Rawfile$)
6768 PRINT TABXY(1,8);"ENTER DATAFILE NUMBERS FOR SAMPLES TO BE REDUCED..."
6769 PRINT TABXY(1,9);"Separate first and last sample-numbers of a continuous sequence with a comma,"
6770 PRINT TABXY(1,10);"separate different continuous sequences or individual samples with a semicolon,"
6772 PRINT TABXY(1,11);"for example, 1,5;12,15;21.  Be sure to include rows with embedded specifiers."
6774 PRINT TABXY(1,14);"Press "&FNH$("k3")&" for ALL datafile sets in memory, "
6780 PRINT TABXY(1,16);"Press "&FNH$("k4")&" to access a "&FNUn$("new")&" raw-data file"
6786!PRINT TABXY(1,18);"Press "&FNH$("k8")&" for HELP"
6792 D_kbd:ON KEY 9 LABEL "    ESCAPE" GOTO Choose
6798 ON KEY 3 LABEL "     ALL" GOTO 6798
6804 ON KEY 4 LABEL "     NEW" GOTO 6804
6810!ON KEY 8 LABEL "    HELP" GOTO 6924
6816 ON KBD ALL GOTO 6840
```

```
6822 DISP "?"
6828 GOTO 6828
6834 !
6840 K=FNGet_key
6846 OFF KBD
6852 OFF KEY
6858 SELECT K
6864 CASE -176
6870   PAUSE
6876 CASE -199              ! k9
6882   GOTO Choose
6888 CASE -204              ! k4
6894   Vcfile(Dfile,Raw0(*),Name$(*),Nsamples,Rawfile$,Escape)
6900   ON 1+Escape GOTO Datafile,Choose
6906 CASE -200              ! k8
6912 ! CALL Help12
6918   GOTO Datafile
6924 CASE -205              ! k3
6930   Firstsample=1
6936   Lastsample=Nsamples
6942   GOTO 7074
6948 CASE 49 TO 57          ! Number-keys 1 through 9
6954   OUTPUT KBD;CHR$(K);
6960   PRINT TABXY(1,18);RPT$(" ",80)
6966   PRINT TABXY(1,16);RPT$(" ",80)
6972   DISP "(enter # to escape)";
6973   LINPUT In$
6975 CASE ELSE
6976   GOTO D_kbd
6977 END SELECT
6978   !
6979 Begun=0
6981 LOOP
6982   REPEAT
6984     Semicolon=POS(In$,";")
6985     IF NOT Semicolon THEN In$=In$&";"
6986   UNTIL Semicolon
6988   Endseq=(Semicolon>1)*(Semicolon-1)+(Semicolon=2)*LEN(In$)
6989   Retrieve(In$[1,Endseq],Nv(*),Ninputs,0)
6990 EXIT IF Ninputs=0
6991   SELECT Ninputs
6992   CASE 0
6996     GOTO Choose
7002   CASE 1
7008     IF Nv(1)=0 THEN Choose
7014     Firstsample=Nv(1)
7020     Lastsample=Nv(1)
7026   CASE 2
7032     Firstsample=Nv(1)
7038     Lastsample=Nv(2)
7044   END SELECT
7068 !
7074   IF NOT Begun THEN GOSUB Inputpb0
7075   Begun=1
7080   Clear
7086   GOTO Start
7092  !
7098  !
7104 Start:ON KEY 9 LABEL "    ESCAPE" GOTO Choose
7110   Kybrd=0
7116   MAT Raw= Raw0! Restore original raw-data file in case converted for 205.
7122   Total_uspiked=0 ! Default is not total-spiked for U.
7128   Prev_fuspkd=0
7134   FOR I=Firstsample TO Lastsample
```

```
7135      DISP FNH$(VAL$(I))
7140      Trialname$=Name$(I)
7146    !
7152    ! Look for labdata-file name in sample-name, load if present.
7158      P=POS(Name$(I),"*L*") ! Indicated by *L* in start of name.
7164      IF P THEN
7170        Labdata$=TRIM$(Name$(I)[P+3])
7176        Q=POS(Labdata$,":")! Look for MSUS specifier- 0 or 1.
7182        IF Q THEN
7188          ON ERROR GOTO 7212
7194          Z=VAL(Labdata$[1+Q])
7200          Labdata$=Labdata$[1,Q-1]
7206          IF Z=0 OR Z=1 THEN MASS STORAGE IS Ms$(Z)
7212          OFF ERROR
7218        END IF
7224        Read_labdata(Labdata$,Error)
7230        IF Error THEN
7236          PRINT USING "3/,K";"PRESS"&FNCt$&"WHEN READY TO RE-START..."
7242          PAUSE
7248          GOTO Choose
7254        END IF
7260        IF Printer THEN PRINTER IS 701
7266        PRINT USING "2/,K";"Data reduced using Labdata File "&Q$&Labdata$&Q$&"."
7272        PRINTER IS CRT
7278        Transfer_labdat
7284      END IF
7290    ! Look for indicator of spike type in sample-name.
7296    ! *208* indicates a Pb-208 spiked sample, *205* a Pb-205 spiked sample,
7302    ! *233* a U-233/236 spkiked sample, *235* a U-235 spiked smaple.
7308    !
7314      IF POS(Name$(I),"*208*") THEN
7320        OUTPUT CRT;"SPIKED WITH Pb-208"
7326        Pb205_spiked=0
7332        Transfer_labdat
7338      END IF
7344      IF POS(Name$(I),"*205*") THEN
7350        OUTPUT CRT;"SPIKED WITH Pb-205"
7356        Pb205_spiked=1
7362        Transfer_labdat
7368      END IF
7374      IF POS(Name$(I),"*233*") THEN
7380        OUTPUT CRT;"SPIKED WITH U-233/U-236"
7386        U233_spiked=1
7392        Transfer_labdat
7398      END IF
7404      IF POS(Name$(I),"*235*") THEN
7410        OUTPUT CRT;"SPIKED WITH U-235"
7416        U233_spiked=0
7422        Transfer_labdat
7428      END IF
7434      IF POS(UPC$(Name$(I)),"*TU*") THEN
7440        Total_uspiked=1
7446        OUTPUT CRT;"TOTAL-SPIKED FOR U-Th"
7452      END IF
7458      IF POS(UPC$(Name$(I)),"*PU*") THEN
7464        Total_uspiked=0
7470        OUTPUT CRT;"U-Th SPIKED IN Pb-CONC ALIQUOT"
7476      END IF
7482      IF POS(UPC$(Name$(I)),"*SAMSPK*") THEN
7488        Have_samspk=1
7494        OUTPUT CRT;"U DATA AS SAMPLE/SPIKE RATIO"
7500      END IF
7506      IF POS(UPC$(Name$(I)),"*368*") THEN
7512        Have_samspk=0
```

```
7518        IF U233_spiked THEN OUTPUT CRT;"U-DATA AS 233/236/238 RATIOS"
7524      END IF
7530  !
7536      IF Raw(I,1)=0 THEN Nexti! If no sample weight, skip to next one.
7542  !
7548      IF Pb205_spiked THEN
7554  ! ****** Table conversion for Pb-205 spiked samples ********
7560  !  Transfer Ith row of R-array to Temp-vector & zero the Ith row
7566        FOR J=1 TO 30
7572          Temp(J)=Raw(I,J)
7578          Raw(I,J)=0
7584        NEXT J
7590  !
7596  !  Sample wt = col. 1, set U-Th spike wts = Pb spike wts
7602        Raw(I,1)=Temp(1)
7608        Raw(I,5)=Temp(2)
7614        Raw(I,6)=Temp(2)
7620        Raw(I,7)=Temp(2)
7626  !
7632  ! Set total & spiked-al wts to 1, unspiked-al wt to zero
7638        Raw(I,2)=1
7644        Raw(I,4)=1
7650        Raw(I,3)=0
7656  !
7662  !  Shift the Pb ratios up 12 columns, put 6/5 data in columns 8-9
7668        FOR J=14 TO 19
7674          Raw(I,J)=Temp(J-11)
7680        NEXT J
7686        Raw(I,8)=Temp(9)
7692        Raw(I,9)=Temp(10)
7698  !
7704  ! Shift the U-Th ratios & all blanks up 9 columns
7710        FOR J=20 TO 26
7716          Raw(I,J)=Temp(J-9)
7722        NEXT J
7728        Raw(I,27)=Temp(19)! 233/236
7734        Raw(I,28)=Temp(20)! %err
7740      ELSE
7746      ! No aliquot wts, so must be total-spiked with all aliquot used
7752        IF Raw(I,3)=0 AND Raw(I,4)=0 AND Raw(I,2)=0 THEN Raw(I,4)=1
7758      ! No total aliquot-wt, so must equal spiked+unspiked
7764        IF Raw(I,2)=0 THEN Raw(I,2)=Raw(I,3)+ABS(Raw(I,4))
7770      ! Negative Pb-spiked al wt, so must be total-spiked for U-Th
7776        IF Raw(I,4)<0 THEN ! Indicates total-spiked for U- this sample only.
7782          Raw(I,4)=ABS(Raw(I,4))! - Overrides previous *PU*
7788          Prev_tuspkd=Total_uspiked
7794          Total_uspiked=1
7800        END IF
7806      END IF
7812  !
7818      GOTO Go
7824  !
7830  Nextsample:IF NOT Printer THEN PRINT USING "2/"
7836      IF Printer THEN WAIT 4! Allow time for HP82905B printer buffer to empty
7842  Nexti:NEXT I
7843    IF Semicolon THEN In$=In$[1+Semicolon]
7845  END LOOP
7846  !
7848  Total_uspiked=Prev_tuspkd ! Restore original
7854  OFF KEY
7860  Whoop
7866  Storefile(Name$(*),Red(*),Firstsample,Lastsample)
7872  GOTO Choose
7878  !
```

```
7884  !
7890 Samspk:Clear
7896 PRINT TABXY(5,12);"PRESS "&FNH$("k0")&" IF YOUR RAW DATA INCLUDES THE SAMPLE-238/SPIKE-233 RATIO"
7902 PRINT TABXY(5,14);"PRESS "&FNH$("k4")&" IF NOT (so must have 233/236 & 233/238 ratios)"
7908 OFF KEY
7914 ON KEY 0 LABEL " HAVE SAM/SPK" GOTO 7944
7920 ON KEY 4 LABEL "   NO SAM/SPK" GOTO 7956
7926 ON KEY 9 LABEL "   ESCAPE" GOTO Choose
7932 GOTO 7932
7938  !
7944 Have_samspk=1
7950 GOTO Choose
7956 Have_samspk=0
7962 GOTO Choose
7968 Endmain:END   ! End of MAIN part of program-- rest is subprograms.
7974 !
7980 !
7986 Err:DEF FNErr$(X)
7992   RETURN "+/-"&VAL$(DROUND(SQR(X),3))&"%"
7998 FNEND
8004 !
8010 Er:DEF FNEr$(X)
8016   RETURN "+/-"&VAL$(X)&"%"
8022 FNEND
8028 !
8034 M:DEF FNM(X)    ! multiply by 1E9, 1E6, OR 100
8040   RETURN X*((X(1/1.E+6)*1.E+9+(X)=1/1.E+6)*(X(.01)*1.E+6+(X)=.01)*100)
8046 FNEND
8052 !
8058 L:DEF FNL$(X)   ! Return appropriate units  (PPB,  PPM,  or %)
8064   F$(1)="PPB"
8070   F$(2)="PPM"
8076   F$(3)="%"
8082   RETURN F$((X(1/1.E+6)+2*(X)=1/1.E+6)*(X(.01)+3*(X)=.01))
8088 FNEND
8094 !
8100 Retrieve:SUB Retrieve(Input_string$,Numeric_value(*),Ninputs,OPTIONAL No_input)
8101    IF NPAR(4 THEN
8106      LINPUT Input_string$
8107    END IF
8112    MAT Numeric_value= (0)
8118    Comma=1
8124    Ninputs=0
8130    ON ERROR GOTO Done
8136    WHILE Comma)0
8142      Numeric_value(1+Ninputs)=VAL(Input_string$)
8148      Ninputs=1+Ninputs
8154      Comma=POS(Input_string$,",")
8160      Input_string$=Input_string$[1+Comma]
8166    END WHILE
8172 Done:SUBEND
8178  !
8184  !
8190 H:DEF FNH$(String$) ! put string in inverse-video
8196   RETURN CHR$(129)&" "&String$&" "&CHR$(128)
8202 FNEND
8208  !
8214  !
8220 Get_key:DEF FNGet_key
8226   ON ERROR GOTO 8244
8232   DIM Key$[2]
8238   Key$=KBD$
8244   OFF ERROR
8250   L=LEN(Key$)
```

```
8256   SELECT L
8262   CASE 1
8268     Keycode=NUM(Key$)
8274   CASE 2
8280     Keycode=NUM(Key$[2,2])-256
8286   END SELECT
8292   IF Keycode=-177 THEN DUMP ALPHA
8298   RETURN Keycode
8304 FNEND
8310 !
8316 !
8322 Bad_input:SUB Bad_input(Crud$)
8328   DISP FNH$(" ***"&Crud$&" *** ")
8334   Clunk
8340   WAIT 2
8346 SUBEND
8352 !
8358 !
8364 DEF FNAliq(Pbunsp_al_equiv,Pbspkd_al_equiv)
8370 !    Returns Pb-unspiked aliquot equivalent sample-wt if an unspiked aliquot exists, otherwise returns Pb
     -spiked aliquot equivalent wt.
8376   IF Pbunsp_al_equiv THEN RETURN Pbunsp_al_equiv
8382   IF NOT Pbunsp_al_equiv THEN RETURN Pbspkd_al_equiv
8388 FNEND
8394 !
8400 !
8406 Un:DEF FNUn$(S$) ! Return input-string as an underlined string
8412   RETURN CHR$(132)&S$&CHR$(128)
8418 FNEND
8424 !
8430 !
8436 Bl:DEF FNBl$(S$) ! Return input-string as blinking, inverse-video
8442   RETURN CHR$(131)&" "&S$&" "&CHR$(128)
8448 FNEND
8454 !
8460 !
8466 Yesno:SUB Yesno(Yesno,OPTIONAL Use_escape)
8472  ! Return 1 if Y-key pressed, 0 if N-key, -2 if k9, -1 & clunk if any other
8478   IF NPAR=2 THEN
8484     E=Use_escape
8490   ELSE
8496     E=1
8502   END IF
8508   IF E THEN ON KEY 9 LABEL "   ESCAPE" GOTO E
8514   ON KBD GOTO 8550
8520   GOTO 8520
8526 !
8532 E:Yesno=-2
8538   SUBEXIT
8544 !
8550   K=FNGet_key
8556   SELECT K
8562   CASE 89,121     ! Y or y
8568     Yesno=1
8574   CASE 78,110     ! N or n
8580     Yesno=0
8586   CASE ELSE
8592     Clunk
8598     Yesno=-1
8604   END SELECT
8610 SUBEND
8616 !
8622 !
8628 Labdata:SUB Labdata(New_run)
```

```
8634  ! Access/edit/redefine datafile containing spike, blank, & mass-discr. data
8640   OPTION BASE 1
8646   COM /Labdata1/ Labdata$,Pbspike$,Uspike$,Thspike$,Pb205_spiked,Mixed_spike,Spike205pg,Spike208pg,Pbspk_
       conc_perr,Spike64,Spike67,Spike68
8652   COM /Labdata2/ Spike65,Spike235pg,Spike235pg_perr,Spike238235,Spike230pg,Spike232230,Pbdisc,Pbdisc_err,
       Udisc,Udisc_err,Thdisc,Thdisc_err,Pbblank_perr
8658   COM /Labdata3/ Ublank_perr,Thblank_perr,Blank64,Blank74,Blank84,Blank64err,Blank74err,Blank84err,Blank6
       474_rho,Blank_6484rho,U233_spiked
8664   COM /Labdata47 Spike233pg,Spike233pg_err,Spike238233,Spike233236
8670   COM /Read_labdat/ Pb208(*),Pb205(*),U235(*),U233(*),Th230(*),Discr(*),Blanks(*),Pb208$,Pb205$,U235$,U23
       3$,Th230$
8676   DIM Lr$(17)[40]
8682   COM /Form/ Prompt$(*),Response$(*),Usc(*),Range(*),Nval(*),Escape
8688   COM /Print/ Printer_ok
8694   COM /Ms/ Ms$(*)
8700   DIM T$[25],Cat$(50)[80],Lfile$(30)[15]
8706   !
8712   Clear     ! Clear screen
8718   IF New_run THEN Newfile
8724   OFF KEY
8730   Newfile=0
8736  !
8742   PRINT TABXY(18,10);"PRESS "&FNH$("N")&" TO DEFINE A NEW LABDATA FILE"
8748   PRINT TABXY(18,12);"PRESS "&FNH$("L")&" TO LOAD ANOTHER LABDATA FILE INTO MEMORY"
8754   PRINT TABXY(18,14);"PRESS "&FNH$("P")&" TO PRINT OR DISPLAY A LABDATA FILE"
8760   PRINT TABXY(18,16);"PRESS "&FNH$("R")&" TO RE-NAME A LABDATA FILE"
8766   IF Edited THEN DISP " (Remember to store your edited LABDATA fle if you want to save the changes)"
8772   PRINT TABXY(3,18);"PRESS THE APPROPRIATE SOFTKEY TO "&FNUn$("EDIT")&" DATA FOR THE "&FNUn$("CORRENT")&"
        LABDATA FILE"
8778   ON KEY 0 LABEL " U233 Spike" GOTO U233_spike_a
8784   ON KEY 1 LABEL " Pb208Spike" GOTO Pb208_spike_a
8790   ON KEY 2 LABEL " Pb205Spike" GOTO Pb205_spike_a
8796   ON KEY 3 LABEL " U235 Spike" GOTO U235_spike_a
8802   ON KEY 4 LABEL " Th230Spike" GOTO Th230_spike_a
8808   ON KEY 5 LABEL "  Mass Discr" GOTO Mass_discrim_a
8814   ON KEY 6 LABEL "   Blanks" GOTO Blanks_a
8820   ON KEY 7 LABEL " Store File" GOTO Store_labdata_a
8826   ON KEY 8 LABEL "    HELP" GOTO Calhelp
8832   ON KEY 9 LABEL "   ESCAPE" GOTO Ldend
8838   ON KBD GOTO 8856
8844   GOTO 8844
8850  !
8856   K=FNGet_key
8862   OFF KBD
8868   OFF KEY
8874   SELECT K
8880   CASE 8                    ! CTRL H
8886 Calhelp:CALL Help11
8892     GOTO Labdata
8898   CASE 80,112               ! p or P
8904     GOTO Print_labdata
8910   CASE 78,110               ! n OR N
8916     GOTO All
8922   CASE 76,108               ! l OR L
8928     GOTO Newfile
8934   CASE 82,114               ! r OR R
8940     GOSUB Labdata_name
8946     GOTO 8712
8952   CASE ELSE
8958     GOTO 8778
8964   END SELECT
8970  !
8976 Blanks_a:GOSUB Blanks
8982   Edited=1
```

```
8988    GOTO Labdata
8994 Pb208_spike_a:GOSUB Pb208_spike
9000    Edited=1
9006    GOTO Labdata
9012 U235_spike_a:GOSUB U235_spike
9018    Edited=1
9024    GOTO Labdata
9030 U233_spike_a:GOSUB U233_spike
9036    Edited=1
9042    GOTO Labdata
9048 Th230_spike_a:GOSUB Th230_spike
9054    Edited=1
9060    GOTO Labdata
9066 Pb205_spike_a:GOSUB Pb205_spike
9072    Edited=1
9078    GOTO Labdata
9084 Mass_discrim_a:GOSUB Mass_discrim
9090    Edited=1
9096    GOTO Labdata
9102 Store_labdata_a:GOSUB Store_labdata
9108    GOTO Labdata
9114  !
9120  !
9126 All:OFF KEY      ! Define a complete new Labdata file
9132    OFF KBD
9138    LOOP
9139      Clear
9144      PRINT USING "11/,3X,K,2/,3X,K,4/";"PLEASE CONFIRM REQUEST TO DEFINE A NEW LABDATA FILE:","DO YOU WANT
       TO PROCEED (Y/N)?"
9150      CALL Yesno(Yes,0)
9156    EXIT IF Yes<>-1
9162      Bad_input("MUST PRESS Y OR N")
9168      DISP
9174    END LOOP
9180    IF NOT Yes THEN Labdata
9186    Newfile=1
9192    !
9198    Pb208$=""
9204    MAT Pb208= (0)
9210    PRINT USING "18/,K";"Do you want to define a Pb-208 spike (Y/N)?"
9216    CALL Yesno(Yes)
9222    IF Yes=-1 OR Yes=-2 THEN Labdata
9228    IF Yes=1 THEN GOSUB Pb208_spike
9234    !
9240    Pb205$=""
9246    MAT Pb205= (0)
9252    PRINT USING "18/,K";"Do you want to define a Pb-205/U/Th spike (Y/N)?"
9258    CALL Yesno(Yes)
9264    IF Yes=-1 OR Yes=-2 THEN Labdata
9270    IF Yes=1 THEN GOSUB Pb205_spike
9276    !
9282 U235:MAT U235= (0)
9288    U235$=""
9294    PRINT USING "18/,K";"Do you want to define a U-235 spike? (Y/N)"
9300    CALL Yesno(Yes)
9306    IF Yes=-1 OR Yes=-2 THEN Labdata
9312    IF Yes=1 THEN GOSUB U235_spike
9318    !
9324 U233:MAT U233= (0)
9330    U233$=""
9336    PRINT USING "18/,K";"Do you want to define a mixed U-233/U-236 spike? (Y/N)"
9342    CALL Yesno(Yes)
9348    IF Yes=-1 OR Yes=-2 THEN Labdata
9354    IF Yes=1 THEN GOSUB U233_spike
```

```
9360   !
9366 Th230:MAT Th230= (0)
9372   Th230$=""
9378   PRINT USING "18/,K";"Do you want to define a Th-230 spike? (Y/N)"
9384   CALL Yesno(Yes)
9390   IF Yes=-1 OR Yes=-2 THEN Labdata
9396   IF Yes=1 THEN GOSUB Th230_spike
9402   !
9408   GOSUB Mass_discrim
9414   GOSUB Blanks
9420   GOSUB Labdata_name
9426   Transfer_labdat
9432   GOSUB Create_labdata
9438   GOSUB Store_labdata
9444   GOTO Labdata
9450   !
9456 Create_labdata:ON ERROR GOTO Cant_create
9462   CREATE BDAT Labdata$,2
9468   OFF ERROR
9474   RETURN
9480   !
9486 Cat0:Dd=0
9492   GOTO Newfile
9498 Cat1:Dd=1
9504   GOTO Newfile
9510   !
9516 Newfile:Newfile=1   ! Indicates file-change
9522   OFF KEY
9532   Clear
9534   MASS STORAGE IS Ms$(Dd)
9540   PRINT USING "80A,/,K,X,K,K,/";RPT$("*",80),"LABDATA FILES PRESENT ON DISK IN DRIVE",Dd,":"
9546   ON ERROR GOTO 9564
9552   CAT TO Cat$(*)
9553   PRINT TABXY(40,2);VAL$(Dd)&":";TAB(50);Cat$(2)
9558   GOTO 9588
9564   Dd=NOT Dd
9566   PRINT TABXY(40,2);VAL$(Dd)&":";TAB(50);Cat$(2)
9570   MASS STORAGE IS Ms$(Dd)
9576   ON ERROR GOTO Nodisk
9582   CAT TO Cat$(*)
9588   OFF ERROR
9594   I=8
9600   J=0
9606   REPEAT
9612     IF Cat$(I)[44,55]=" 2      256 " THEN
9613       J=J+1
9615       Lfile$(J)=TRIM$(Cat$(I)[1,15])
9619       Rowcol(J,Row,Col)
9627       PRINT TABXY(Col,Row);" "&Lfile$(J)&" "
9636     END IF
9642     I=I+1
9648   UNTIL Cat$(I)="" OR I=50
9649   Maxj=J
9650   Maxrow=Row
9654   IF J=0 THEN PRINT "<<<<<<<<<<<<<<<<< NO LABDATA FILES PRESENT ON THIS DISK >>>>>>>>>>>>>>>>>>"
9660   OFF ERROR
9666   PRINT USING "/,K";RPT$("*",80)
9672   IF New_run THEN PRINT USING "/,K";"YOU MUST HAVE A LABDATA FILE IN MEMORY TO PROCEED."
9678   PRINT USING "2/,K";"SELECT A LABDATA FILE WITH ARROW KEYS, THEN PRESS "&FNH$("EXECUTE")
9684   IF NOT New_run THEN ON KEY 9 LABEL "    ESCAPE" GOTO Labdata
9685   J=1
9686   Oldj=1
9687   Rowcol(J,Row,Col)
9688   PRINT TABXY(Col,Row),FNB1$(Lfile$(J))
```

```
9690   ON KEY 0 LABEL "   DRIVE 0" GOTO Cat0
9696   ON KEY 1 LABEL "   DRIVE 1" GOTO Cat1
9702   IF New_run THEN
9708     ON KEY 4 LABEL "  DEFINE NEW" GOTO All
9714     PRINT TABXY(1,16);"(Press "&FNH$("k4")&" to define a "&FNUn$("new")&" LABDATA file, "
9720   END IF
9726   PRINT TABXY(2,18);"Press "&FNH$("k0")&" or "&FNH$("k1")&" to change the LABDATA disk drive)"
9732 Lkey:ON KBD GOTO 9744
9738   GOTO 9738
9739   !
9744   K=FNGet key
9754   SELECT K
9758   CASE -196,-194,-170,-162              ! Left, Right, Up, Down arrow
9759     J=J+(K=-194)-(K=-196)-4*(K=-162)+4*(K=-170) ! Move file cursor
9760     IF J<1 THEN J=Maxj                  ! Wraparound
9761     IF J>Maxj THEN J=1                  !
9762     Rowcol(Oldj,Row,Col)
9764     PRINT TABXY(Col,Row);" "&Lfile$(Oldj)&" "
9766     Rowcol(J,Row,Col)
9767     PRINT TABXY(Col,Row);FNBl$(Lfile$(J))
9768     BEEP 440,.05
9770     Oldj=J
9771     GOTO Lkey
9772   CASE -168                             ! EXECUTE key
9773     Labdata$=Lfile$(J)
9781   CASE ELSE
9791     GOTO Lkey
9793   END SELECT
9798   !
9799   OFF KBD
9800   OFF KEY
9804   Read_labdata(Labdata$,Error)
9810   IF Error THEN Labdata
9816   Transfer_labdat
9822   ON 1+New_run GOTO Labdata,Print_labdata
9828   !
9834 Labdata_name:      ! Define a name for the labdata file
9840   REPEAT
9846     T$=""
9852     PRINT USING "18/,K";"Name for this Labdata File? ((=10 characters;    enter "&FNH$("*")&" to escape)"
9858     INPUT T$[1,25]
9864     T$=TRIM$(T$)
9870   UNTIL T$()""
9876   IF T$="*" THEN Labdata
9882   Labdata$=T$
9888   BEEP
9894   RETURN
9900   !
9906 Nodisk:OFF ERROR
9912   Clear
9918   PRINT TABXY(15,10);FNH$("*** CAN'T ACCESS DISK IN SPECIFIED DRIVE ***")
9924   PRINT TABXY(9,12);"-- press "&FNCt$&" when you have a valid disk in the drive ---"
9930   Clunk
9936   PAUSE
9942   GOTO Newfile
9948   !
9954 Pb208_spike:   ! Enter data for a Pb-208 or Pb-206 spike
9960   DATA " Pb-208 SPIKE: ","",SPIKE NAME,"",MIXED WITH U-235 (Y/N)?,MOLES 208 PER GRAM,UNCERTAINTY (in %) O
       F [208],"",206/204,206/207,206/208
9966   DATA 0,0,0,0,-1,-1,0,0,-2,-2,1E-15,1E-5,0,20,0,0,0,1E6,0,1E6,0,1E6
9972   DATA "","",??,"","N",??,0,"",??,??,??
9978   DATA 0,0,1,0,1,1,1,0,1,1,1
9984   REDIM Prompt$(11),Range(11,2),Response$(11),Use(11),Nval(11),Lr$(11)
9990   MAT Lr$= ("")
```

```
9996   RESTORE 9960
10002  Lr$(3)=Pb208$
10008  IF Pb208(1) THEN
10014    Lr$(5)="Y"
10020  ELSE
10026    Lr$(5)="N"
10032  END IF
10038  FOR I=2 TO 6
10044    Lr$(I+4+(I)2))=VAL$(Pb208(I))
10050  NEXT I
10056  READ Prompt$(*),Range(*),Response$(*),Use(*)
10062  IF NOT Newfile THEN MAT Response$= Lr$
10068  Form(Lr$(*),1)
10074  IF Escape THEN Labdata
10080  Pb208$=TRIM$(Response$(3)[1,15])
10086  Pb208(1)=(UPC$(TRIM$(Response$(5)))="Y")
10092  FOR I=2 TO 6
10098    Pb208(I)=Nval(I+4+(I)2))
10104  NEXT I
10110  RETURN
10116 !
10122 Pb205_spike: ! Enter data for a mixed Pb-205/U/Th spike
10128  Clear
10134  OFF KEY
10140  LOOP
10146    PRINT TABXY(1,15);"IS THIS Pb-205 SPIKE MIXED WITH U-235 (1)  OR U-233/U-236 (2)?"
10152    INPUT U36
10158  EXIT IF U36=1 OR U36=2
10164    Bad_input("ENTER EITHER 1 OR 2")
10170  END LOOP
10176  U36=U36-1
10182  DATA  Pb-205 MIXED SPIKE: ,"",SPIKE NAME,MOLES Pb-205 PER GRAM,MOLES U-235  PER GRAM,MOLES Th-230 PER
         GRAM
10188  DATA PERCENT UNCERTAINTY IN [205],"   ''       ''       ' [235]","   ''         ''     ' [230]","",206/
       205,206/204,206/207,206/208,238/235,"",232/230
10194  DATA "" "",??,??,??,??,"0","0","0","0",??,??,??,??,??,"",??
10200  DATA 0,0,0,0,-1,-1,1E-15,1E-6,1E-15,1E-5,1E-15,1E-5,0,20,0,20,0,20,0,0,0,1,0,1E6,0,1E6,0,1E6,1E-15,1,.0
       1,100,1E-15,1
10206  DATA 0,0,1,1,1,1,1,1,1,0,1,1,1,1,1,0,1
10212  REDIM Prompt$(17),Response$(17),Range(17,2),Use(17),Nval(17),Lr$(17)
10218  MAT Lr$= ("")
10224  RESTORE 10182
10230  READ Prompt$(*),Response$(*),Range(*),Use(*)
10236  IF U36 THEN
10242    Prompt$(5)="MOLES U-233 PER GRAM"
10248    Prompt$(8)="   ''       ''       ' [233]"
10254    Prompt$(15)="238/233"
10260    Prompt$(16)="233/236"
10266    Use(16)=1
10272    Response$(16)="??"
10278  END IF
10284  Lr$(3)=Pb205$
10290  FOR I=1 TO 13
10296    Lr$(I+3+(I)6))=VAL$(Pb205(I))
10302  NEXT I
10308  IF NOT U36 THEN Lr$(16)=""
10314  IF U36 AND Lr$(16)="0" THEN Lr$(16)="??"
10320  IF NOT Newfile THEN MAT Response$= Lr$
10326  Form(Lr$(*),1)
10332  IF Escape THEN Labdata
10338  Pb205$=TRIM$(Response$(3)[1,15])
10344  MAT Pb205= (0)
10350  FOR I=1 TO 13
10356    Pb205(I)=Nval(I+3+(I)6))
```

```
10362  NEXT I
10368  RETURN
10374  !
10380 U235_spike: ! Enter data for a U-235 spike
10386  DATA "U-235 SPIKE: ,"",SPIKE NAME,"",MOLES U-235 PER GRAM,% UNCERTAINTY IN [235],"",238/235,"","",??,
       "" ?? "0" "" ??
10392  DATA 0,0,0,0,-1,-1,0,0,1E-15,1E-5,0,20,0,0,0,1E6
10398  DATA 0,0,1,0,1,1,0,1
10404  REDIM Prompt$(8),Response$(8),Range(8,2),Use(8),Nval(8),Lr$(8)
10410  MAT Lr$= ("")
10416  RESTORE 10386
10422  READ Prompt$(*),Response$(*),Range(*),Use(*)
10428  Lr$(3)=U235$
10434  Lr$(5)=VAL$(U235(1))
10440  Lr$(6)=VAL$(U235(2))
10446  Lr$(6)=VAL$(U235(3))
10452  IF NOT Newfile THEN MAT Response$= Lr$
10458  Form(Lr$(*),1)
10464  IF Escape THEN Labdata
10470  U235$=TRIM$(Response$(3)[1,15])
10476  U235(1)=Nval(5)  ! [235]
10482  U235(2)=Nval(6)  ! %+/-
10488  U235(3)=Nval(8)  ! 238/235
10494  RETURN
10500  !
10506 U233_spike: ! Enter data for a mixed U-233/U-236 spike
10512  DATA "U-233 - U-236 MIXED SPIKE: ,"",SPIKE NAME,"",MOLES U-233 PER GRAM,% UNCERTAINTY IN [233],238/23
       3,233/236,"","",??,"",??,"0",??,??
10518  DATA 0,0,0,0,-1,-1,0,0,1E-15,1E-5,0,20,0,1E6,0,1E6
10524  DATA 0,0,1,0,1,1,1,1
10530  REDIM Prompt$(8),Response$(8),Range(8,2),Use(8),Nval(8),Lr$(8)
10536  MAT Lr$= ("")
10542  RESTORE 10512
10548  READ Prompt$(*),Response$(*),Range(*),Use(*)
10554  Lr$(3)=U233$
10560  FOR I=5 TO 8
10566    Lr$(I)=VAL$(U233(I-4))
10572  NEXT I
10578  IF NOT Newfile THEN MAT Response$= Lr$
10584  Form(Lr$(*),1)
10590  IF Escape THEN Labdata
10596  U233$=TRIM$(Response$(3)[1,15])
10602  U233(1)=Nval(5)  ! [233]
10608  U233(2)=Nval(6)  ! % +/-
10614  U233(3)=Nval(7)  ! 238/233
10620  U233(4)=Nval(8)  ! 233/236
10626  RETURN
10632  !
10638 Th230_spike: ! Enter data for a Th-230 spike
10644  DATA "Th-230 SPIKE: ,"",SPIKE NAME,"",MOLES Th-230 PER GRAM,% UNCERTAINTY IN [230],"",232/230,"","",?
       ?,"",?? "0" "" ??
10650  DATA 0,0,0,0,-1,-1,0,0,1E-15,1E-5,0,20,0,0,0,1
10656  DATA 0,0,1,0,1,1,0,1
10662  REDIM Prompt$(8),Response$(8),Range(8,2),Use(8),Nval(8),Lr$(8)
10668  MAT Lr$= ("")
10674  RESTORE 10644
10680  READ Prompt$(*),Response$(*),Range(*),Use(*)
10686  Lr$(3)=Th230$
10692  Lr$(5)=VAL$(Th230(1))
10698  Lr$(6)=VAL$(Th230(2))
10704  Lr$(8)=VAL$(Th230(3))
10710  IF NOT Newfile THEN MAT Response$= Lr$
10716  Form(Lr$(*),1)
10722  IF Escape THEN Labdata
```

```
10728  Th230$=TRIM$(Response$(3)[1,15])
10734  Th230(1)=Nval(5)  ! [230]
10740  Th230(2)=Nval(6)  ! %+/-
10746  Th230(3)=Nval(8)  ! 232/230
10752  RETURN
10758 !
10764 Mass discrim: ! enter data for standard mass-discrimination for mss-spectrometer runs
10770  DATA " MASS DISCRIMINATION: ",(ALL IN PERCENT PER MASS-UNIT),"",FOR Pb RUNS," uncertainty","",FOR U
       RUNS," uncertainty","",FOR Th RUNS," uncertainty"
10776  DATA "" "" "" ??,??,"",??,??,"",??,??
10782  DATA 0,0,0,0,0,0,-1,1,0,1,0,0,-1,1,0,1,0,0,-1,1,0,1
10788  DATA 0,0,0,1,1,0,1,1,0,1,1
10794  RESTORE 10770
10800  REDIM Prompt$(11),Response$(11),Range(11,2),Use(11),Nval(11),Lr$(11)
10806  MAT Lr$= ("")
10812  READ Prompt$(*),Response$(*),Range(*),Use(*)
10818  FOR I=1 TO 6
10824    Lr$(I+3+(I)2)+(I)4))=VAL$(Discr(I))
10830  NEXT I
10836  IF NOT Newfile THEN MAT Response$= Lr$
10842  Form(Lr$(*),1)
10848  IF Escape THEN Labdata
10854  Discr(1)=Nval(4)
10860  Discr(2)=Nval(5)
10866  Discr(3)=Nval(7)
10872  Discr(4)=Nval(8)
10878  Discr(5)=Nval(10)
10884  Discr(6)=Nval(11)
10890  RETURN
10896 !
10902 Blanks:   ! Enter data for Pb-U-Th blanks
10908  DATA    BLANKS:   ,% Uncertainty IN Pb BLANK,"'      ''      ' U   ''" "'      ''      ' Th   ''" ""
10914  DATA BLANK-Pb 206/204,"  Uncertainty (absolute)","",BLANK-Pb 207/204," 'Uncertainty (absolute)","",BLAN
       K-Pb 208/204,"  Uncertainty (absolute)"
10920  DATA "",BLANK-Pb 6/4-7/4 ERROR-CORREL.,BLANK-Pb 6/4-8/4 ERROR-CORREL.
10926  DATA "",??,??,??,"",??,??,"",??,??,"",??,??
10932  DATA 0,0,0,1E4,0,1E4,0,1E4,0,0,12,30,0,30,0,0,12,20,0,10,0,0,32,44,0,15,0,0,-1,1,-1,1
10938  DATA 0,1,1,1,0,1,1,0,1,1,0,1,1,0,1,1
10944  RESTORE 10908
10950  REDIM Prompt$(16),Response$(16),Range(16,2),Use(16),Nval(16),Lr$(16)
10956  MAT Lr$= ("")
10962  READ Prompt$(*),Response$(*),Range(*),Use(*)
10968  Lr$(2)=VAL$(Blanks(1))
10974  Lr$(3)=VAL$(Blanks(2))
10980  Lr$(4)=VAL$(Blanks(3))
10986  Lr$(6)=VAL$(Blanks(4))
10992  Lr$(7)=VAL$(Blanks(5))
10998  Lr$(9)=VAL$(Blanks(6))
11004  Lr$(10)=VAL$(Blanks(7))
11010  Lr$(12)=VAL$(Blanks(8))
11016  Lr$(13)=VAL$(Blanks(9))
11022  Lr$(15)=VAL$(Blanks(10))
11028  Lr$(16)=VAL$(Blanks(11))
11034  IF NOT Newfile THEN MAT Response$= Lr$
11040  !
11046  Form(Lr$(*),1)
11052  IF Escape THEN Labdata
11058  Blanks(1)=Nval(2)
11064  Blanks(2)=Nval(3)
11070  Blanks(3)=Nval(4)
11076  Blanks(4)=Nval(6)
11082  Blanks(5)=Nval(7)
11088  Blanks(6)=Nval(9)
11094  Blanks(7)=Nval(10)
```

```
11100  Blanks(8)=Nval(12)
11106  Blanks(9)=Nval(13)
11112  Blanks(10)=Nval(15)
11118  Blanks(11)=Nval(16)
11124  RETURN
11130 !
11136 Print_labdata:OFF KEY   ! print out or display contents of a labdata file
11142  OFF KBD
11148  Clear      ! Clear screen
11154  IF NOT New_run THEN
11160    P=POS(Labdata$,":")
11166    IF P THEN Labdata$=Labdata$[1,P-1]
11172    PRINT TABXY(1,17);"Do you want a hard-copy of this  ";CHR$(34)&Labdata$&CHR$(34);"  labdata-file prin
     tout (Y/N)?"
11178    Yes=-1
11184    REPEAT
11190      CALL Yesno(Yes)
11196      DISP
11202      SELECT Yes
11208      CASE 1
11214        Printer_ok=1
11220        ON TIMEOUT 7,.1 CALL Printer_timeout
11226        PRINTER IS 701
11232        PRINT
11238        IF Printer_ok THEN
11244          OFF TIMEOUT
11250          PRINT USING "K,5/";CHR$(27)&"&k0S"! normal-size print
11256        ELSE
11262          PRINTER IS CRT
11268          GOTO Labdata
11274        END IF
11280      CASE 0
11286        PRINTER IS CRT
11292      END SELECT
11298    UNTIL Yes=1 OR Yes=0 OR Yes=-2
11304    IF Yes=-2 THEN Labdata
11310    IF Yes=1 THEN PRINT RPT$("-",80)
11316    IF Yes=0 THEN CALL Clear
11322  END IF
11328  PRINT USING "K,/";"DATA FROM LABDATA FILE  "&Q$&Labdata$&Q$&":"
11334  IF Yes THEN PRINT
11340  IMAGE "[",3A,"] = ",D.4DE,"  +/-",DD.DD,"% moles/g"
11346  IF Pb208(2) THEN
11352    PRINT "Pb-208 Spike  ("&Pb208$&"):"
11358    IF Yes THEN PRINT
11364    PRINT USING 11340;VAL$(208),Pb208(2),Pb208(3)
11370    IF Pb208(1) THEN
11376      PRINT "(this is a Pb-U-[Th] mixed spike)"
11382    ELSE
11388      PRINT "(not a mixed Pb/U spike)"
11394    END IF
11400    PRINT "206/204=";Pb208(4);TAB(23);"206/207=";Pb208(5);TAB(46);"206/208=";Pb208(6)
11406    IF Yes THEN PRINT
11412  END IF
11418  IF Pb205(1) THEN
11424    PRINT "Pb-205 mixed spike   ("&Pb205$&"):"
11430    IF Yes THEN PRINT
11436    U36=(Pb205(12)()0)
11442    PRINT USING 11340;VAL$(205),Pb205(1),Pb205(4)
11448    PRINT USING 11340;VAL$(235),Pb205(2),Pb205(5)
11454    PRINT USING 11340;VAL$(230),Pb205(3),Pb205(6)
11460    IF Yes THEN PRINT
11466    PRINT "206/205 =";Pb205(7);TAB(35);
11472    IF NOT U36 THEN PRINT "238/235 =";Pb205(11)
```

```
11478    IF U36 THEN PRINT "238/233 =";Pb205(11);TAB(60);"233/236=";Pb205(12)
11484    PRINT "206/204 =";Pb205(8);TAB(35);"232/230 =";Pb205(13)
11490    PRINT "206/207 =";Pb205(9)
11496    PRINT "206/208 =";Pb205(10)
11502    IF Yes THEN PRINT
11508  END IF
11514  IF U235(1) THEN
11520    PRINT "U-235 spike  ("&U235$&"):"
11526    IF Yes THEN PRINT
11532    PRINT USING 11340;VAL$(235),U235(1),U235(2)
11538    PRINT "238/235 =";U235(3)
11544    IF Yes THEN PRINT
11550  END IF
11556  IF U233(1) THEN
11562    PRINT "Mixed U-233/U-236 spike  ("&U233$&"):"
11568    IF Yes THEN PRINT
11574    PRINT USING 11340;VAL$(233),U233(1),U233(2)
11580    PRINT "233/236 =";U233(3);TAB(24);"233/238 =";U233(4)
11586    IF Yes THEN PRINT
11592  END IF
11598  IF Th230(1) THEN
11604    PRINT "Th-spike  ("&Th230$&"):"
11610    IF Yes THEN PRINT
11616    PRINT USING 11340;VAL$(230),Th230(1),Th230(2)
11622    PRINT "232/230 =";Th230(3)
11628    IF Yes THEN PRINT
11634  END IF
11640  !
11646  PRINT "Average mass-discrimination during mass-spectrometer runs, in %/a.m.u. --"
11652  IF Yes THEN PRINT
11658  PRINT "Pb:  ";Discr(1);"+/-";Discr(2);TAB(25);"U: ";Discr(3);"+/-";Discr(4);TAB(50);"Th: ";Discr(5);"+/
       -";Discr(6)
11664  IF Yes THEN PRINT
11670  PRINT "Average Blanks:"
11676  IF Yes THEN PRINT
11682  PRINT "Uncertainty in assigned amount:  Pb - "&VAL$(Blanks(1))&"%";TAB(48);"U - "&VAL$(Blanks(2))&"%";T
       AB(63);"Th - "&VAL$(Blanks(3))&"%"
11688  IF Yes THEN PRINT
11694  PRINT "Pb blank ratios and uncertainties:"
11700  PRINT "206/204 = "&VAL$(Blanks(4))&"+/-"&VAL$(Blanks(7));TAB(26);
11706  PRINT "207/204 = "&VAL$(Blanks(5))&"+/-"&VAL$(Blanks(8));TAB(52);
11712  PRINT "208/204 = "&VAL$(Blanks(6))&"+/-"&VAL$(Blanks(9))
11718  PRINT "Error-Correlations: 206/204-207/204=";Blanks(10);TAB(45);"206/204-208/204=";Blanks(11)
11724  IF New_run THEN SUBEXIT
11730  IF Yes THEN
11736    PRINT USING "K,9/";RPT$("-",80)
11742    PRINTER IS CRT
11748  ELSE
11754    PRINT USING "/,K";"Press"&FNCt$&"to continue, use arrow-keys to scroll display."
11760    PAUSE
11766  END IF
11772  GOTO Labdata
11778  !
11784 Store_labdata:OFF KEY
11790  OFF KBD
11796  Clear
11802 Storefile:ON ERROR GOTO Bad_write
11803  REPEAT
11805    PRINT USING "18/,K,/";"WHICH DRIVE (0 OR 1) DO YOU WANT TO STORE THE LABDATA FILE ON?"
11806    INPUT D
11807  UNTIL D=0 OR D=1
11808  Clear
11810  DISP "Storing file "&CHR$(34)&Labdata$&CHR$(34)&"..."
11814  ASSIGN @N1 TO Labdata$&Ms$(D)
```

```
11820  OUTPUT @N1;Pb208$,Pb208(*),Pb205$,Pb205(*),U235$,U235(*),U233$,U233(*),Th230$,Th230(*),Blanks(*),Discr(
       *)
11826  OFF ERROR
11832  ASSIGN @N1 TO *
11838  P=POS(Labdata$,":")+POS(Labdata$,".")
11844  IF P THEN Labdata$=Labdata$[1,P-1]
11850  Whoop
11856  PRINT USING "/,K,K,/";Labdata$&" STORED."
11862  DISP
11868  RETURN
11874  !
11880  !
11886  Bad_write:       ! can't store Labdata file on disk
11892   IF ERRN=56 THEN ! no such file, so need to create.
11898  Create_file:ON ERROR GOTO Cant_create
11904     CREATE BDAT Labdata$,2
11910     OFF ERROR
11916     GOTO Storefile
11922   ELSE
11928     Clunk
11934  Cant_create:PRINT
11940     OFF ERROR
11946     IF ERRN=54 THEN
11952       PRINT "*** FILE "&Labdata$&" ALREADY EXISTS.  DO YOU WANT TO OVERWRITE WITH NEW DATA (Y/N)?"
11958       CALL Yesno(Yes)
11964       IF Yes THEN
11970         PURGE Labdata$
11976         GOTO Create_file
11982       ELSE
11983         Clear
11988         PRINT USING "18/,K,9/";"CAN'T CREATE FILE.  CORRECT PROBLEM, THEN PRESS"&FNCt$
11994         PAUSE
12000         GOTO Labdata
12006       END IF
12007     ELSE
12008       GOTO 11983
12012     END IF
12018   END IF
12024  !
12032  Ldend:SUBEND
12036  !
12042  !
12048  Transfer_labdat:SUB Transfer_labdat
12054  ! Transfer the array-variables from the labdata file to simple, mnemonically useful variables.
12060   OPTION BASE 1
12066   COM /Labdata1/ Labdata$,Pbspike$,Uspike$,Thspike$,Pb205_spiked,Mixed_spike,Spike205pg,Spike208pg,Pbspk_
       conc_perr,Spike64,Spike67,Spike68
12072   COM /Labdata2/ Spike65,Spike235pg,Spike235pg_perr,Spike238235,Spike230pg,Spike232230,Pbdisc,Pbdisc_err,
       Udisc,Udisc_err,Thdisc,Thdisc_err,Pbblank_perr
12078   COM /Labdata3/ Ublank_perr,Th6lank_perr,Blank64,Blank74,Blank84,Blank64err,Blank74err,Blank84err,Blank6
       474_rho,Blank_6484rho,U233_spiked
12084   COM /Labdata4/ Spike233pg,Spike233pg_err,Spike238233,Spike233236
12090   COM /Read_labdat/ Pb208(*),Pb205(*),U235(*),U233(*),Th230(*),Discr(*),Blanks(*),Pb208$,Pb205$,U235$,U23
       3$,Th230$
12096   !
12102   !
12108   IF Pb205_spiked THEN  ! ---------------- Pb-205 SPIKE ----------------
12114     Pbspike$=Pb205$
12120     Uspike$=Pb205$
12126     Thspike$=Pb205$
12132     U233_spiked=(Pb205(12)()0)
12138     Spike205pg=Pb205(1)
12144     Pbspk_conc_perr=Pb205(4)
12150     Spike64=Pb205(8)
```

```
12156    Spike65=Pb205(7)
12162    Spike67=Pb205(9)
12168    Spike68=Pb205(10)
12174    IF NOT U233_spiked THEN  ! ---- (U-235 IN Pb-205 SPIKE) -----
12180      Spike235pg=Pb205(2)
12186      Spike235pg_perr=Pb205(5)
12192      Spike238235=Pb205(11)
12198    ELSE ! ------------------------ (U-233/236 IN Pb-205 SPIKE) ---
12204      Spike233pg=Pb205(2)
12210      Spike233pg_perr=Pb205(5)
12216      Spike233236=Pb205(12)
12222      Spike238233=Pb205(11)
12228    END IF ! ---------------------- (Th-230 IN Pb-205 SPIKE) --------
12234    Spike230pg=Pb205(3)
12240    Spike230pg_perr=Pb205(6)
12246    Spike232230=Pb205(13)
12252    Mixed_spike=1
12258  ELSE   ! ------------------------- Pb-208 SPIKE ---------------------
12264    Pbspike$=Pb208$
12270    Mixed_spike=Pb208(1)
12276    Spike208pg=Pb208(2)
12282    Pbspk_conc_perr=Pb208(3)
12288    Spike64=Pb208(4)
12294    Spike67=Pb208(5)
12300    Spike68=Pb208(6)
12306    IF U233_spiked THEN  ! -------- U-233 SPIKE ----------------------
12312      Uspike$=U233$
12318      Spike233pg=U233(1)
12324      Spike233pg_perr=U233(2)
12330      Spike233236=U233(4)
12336      Spike238233=U235(3)
12342    ELSE ! ---------------------- U-235 SPIKE ----------------------
12348      Uspike$=U235$
12354      Spike235pg=U235(1)
12360      Spike235pg_perr=U235(2)
12366      Spike238235=U235(3)
12372    END IF
12378    Thspike$=Th230$ ! ------------ Th-230 SPIKE -------------------------
12384    Spike230pg=Th230(1)
12390    Spike230pg_perr=Th230(2)
12396    Spike232230=Th230(3)
12402    Pbdisc=Discr(1) ! ------------ MASS-DISCRIMINATION ------------------
12408    Pbdisc_err=Discr(2)
12414    Udisc=Discr(3)
12420    Udisc_err=Discr(4)
12426    Thdisc=Discr(5)
12432    Thdisc_err=Discr(6)
12438    Pbblank_perr=Blanks(1) ! ------- BLANKS -------------------------------
12444    Ublank_perr=Blanks(2)
12450    Thblank_perr=Blanks(3)
12456    Blank64=Blanks(4)
12462    Blank74=Blanks(5)
12468    Blank84=Blanks(6)
12474    Blank64err=Blanks(7)
12480    Blank74err=Blanks(8)
12486    Blank84err=Blanks(9)
12492    Blank6474_rho=Blanks(10)
12498    Blank6484_rho=Blanks(11)
12504  END IF
12510 SUBEND
12516 !
12522 !
12528 Read_labdata:SUB Read_labdata(Labdata$,OPTIONAL Error)
12534  OPTION BASE 1
```

```
12540  COM /Read_labdat/ Pb208(*),Pb205(*),U235(*),U233(*),Th230(*),Discr(*),Blanks(*),Pb208$,Pb205$,U235$,U23
       3$,Th230$
12546  COM /Ms/ Ms$(*)
12552  !
12558  Clear
12564  IF NPAR=2 THEN Error=0
12570  DISP "LOADING "&CHR$(34)&Labdata$&CHR$(34)&"..."
12576  ON ERROR GOTO Bad_read
12582  ASSIGN @N1 TO Labdata$
12588  ENTER @N1;Pb208$,Pb208(*),Pb205$,Pb205(*),U235$,U235(*),U233$,U233(*),Th230$,Th230(*),Blanks(*),Discr(*
       )
12594  OFF ERROR
12600  DISP
12606  SUBEXIT
12612  !
12618  Bad_read:     ! Can't read specified Labdata file
12624   IF NOT POS(Labdata$,":") THEN ! If user didn't indicate MSUS, try both
12630     ON ERROR GOTO 12666
12636     ASSIGN @N1 TO Labdata$&Ms$(0)
12642     ENTER @N1;Pb208$,Pb208(*),Pb205$,Pb205(*),U235$,U235(*),U233$,U233(*),Th230$,Th230(*),Blanks(*),Discr
       (*)
12648     OFF ERROR
12654     SUBEXIT
12660   !
12666     ON ERROR GOTO 12708
12672     ASSIGN @N1 TO Labdata$&Ms$(1)
12678     ENTER @N1;Pb208$,Pb208(*),Pb205$,Pb205(*),U235$,U235(*),U233$,U233(*),Th230$,Th230(*),Blanks(*),Discr
       (*)
12684     OFF ERROR
12690     SUBEXIT
12696   END IF
12702   !
12708   Clunk
12714   OFF ERROR
12720   DISP
12726   OFF KEY
12732   OFF KBD
12738   IF NPAR=2 THEN Error=1
12744   PRINT USING "K,2/,K";"CAN'T ACCESS FILE "&CHR$(34)&Labdata$&CHR$(34)&" --","CHECK SPELLING OF FILE- NAM
       E INCLUDING  UPPERCASE/LOWERCASE, TRY AGAIN."
12750   WAIT 3
12756   SUBEXIT
12762   !
12768   PRINT USING "2/,K,3/";"CAN'T READ FILE  "&Labdata$&"  -- CHECK NAME AND/OR DISK, PRESS"&FNCt$&"WHEN REA
       DY"
12774   GOTO 12750
12780 SUBEND
12786 !
12792 !
12798 Pb_pb_age:SUB Pb_pb_age(R76,Age,OPTIONAL R76_err,Age_err)
12804   ! calculate Pb-2077206 age and (optional) error
12810   OPTION BASE 1
12816   DIM Pb_pb_age(3)
12822   U238_235=137.88
12828   Lambda238=1.55125E-4
12834   Lambda235=9.8485E-4
12840   Age=0
12846   MAT Pb_pb_age= (0)
12852   Calc_errs=0
12858   !
12864   FOR I=2-Calc_errs TO 2+Calc_errors
12870     R=R76
12876     IF Calc_errs THEN R=R+(I-2)*R76_err
12882     IF R).0156 AND R<1.9 THEN
```

```
12888       Trial_t=4500*(SGN(-(1/2)+(R)Lambda235/(Lambda238*U238_235)))+(R).7))
12894  !
12900       Change=1
12906       REPEAT
12912         F=Lambda238*EXP(Trial_t*(Lambda238-Lambda235))/Lambda235
12918         T=LOG(1+(EXP(Trial_t*Lambda238)-1-F*(EXP(Trial_t*Lambda235)-1))/(1/(U238_235*R)-F))/Lambda235
12924         Change=ABS(T-Trial_t)
12930         Trial_t=T
12936       UNTIL Change<.01
12942       Pb_pb_age(I)=T
12948     END IF
12954   NEXT I
12960   Age=Pb_pb_age(2)
12966   IF Calc_errs AND Pb_pb_age(1) AND Pb_pb_age(3) THEN Age_err=ABS(Pb_pb_age(3)-Pb_pb_age(1))/2
12972  !
12978  SUBEND
12984  !
12990  !
12996  Yes:DEF FNYes(S$)
13002   IF UPC$(TRIM$(S$))="Y" THEN RETURN 1
13008   IF UPC$(TRIM$(S$))="N" THEN RETURN 0
13014   RETURN -1
13020  FNEND
13026  !
13032  !
13038  Center:DEF FNCenter$(S$)   ! create a centered string
13044   DIM Pad$[80]
13050   L=LEN(S$)
13056   IF L<80 THEN
13062     Pad$=RPT$(" ",(80-L)/2)
13068     RETURN Pad$&S$&Pad$
13074   ELSE
13080     RETURN S$
13086   END IF
13092  FNEND
13098  !
13104  !
13110  Vcfile:SUB Vcfile(Dfile,Raw(*),Name$(*),Nsamples,Rawfile0$,Escape)
13116  !
13122  ! Subprogram to access VISICALC /PF files.  The VISICALC files must have
13128  !   the following attributes:  The file title, if any, must occupy the
13134  !   first row of the file, and will be printed out when the PRDAT
13140  !   accesses the file.
13146  !
13152  !   The file must have been set for a column-width of 9.
13158  !
13164  !   The column-names or headings can occupy 2 rows, but must appear dir-
13170  !     ectly above a line of "equals" signs (==========) which serves as
13176  !     both an indicator of the column-heading rows and as a visual double-
13182  !     underscore sign.
13188  !
13194  !   The sammple or row names are assumed to be in the first two columns
13200  !     (A and B) of the file.
13206  !
13212  !   The file must have been stored with the printer-width set at 80
13218  !     (the default value).
13224  !
13230  !   The file can contain up to 101 rows of sample-data and up to
13236  !     50 columns.
13242  !
13248  !   The raw-data file can contain the following specifiers within the
13254  !    sample-name, whose effect will occur when that row is accessed
13260  !    during data-reduction (affects sample in that row and any
13266  !    succeeding samples, unless changed by a later specifier):
```

```
13272 !
13278 !   *L* followed by the name of a LABDATA file will cause that file to
13284 !     be loaded and used.
13290 !   *TU* indicates that samples were total-spiked for U (and Th).
13296 !   *PU* indicates that samples were spiked for U (and Th) in the same
13302 !     aliquot as the Pb-spiked aliquot (default).
13308 !   *208* indicates that samples were spiked with a Pb-208 (or Pb-206
13314 !     spike rather than a Pb-205 spike.
13320 !   *205* indicates that samples were total-spiked with a mixed Pb-205/
13326 !     U-235/Th-230 spike.
13332 !   *233* indicates that samples were spiked with a mixed U-233/U-236
13338 !     spike.
13344 !   *235* indicates that samples were spiked with a U-235 spike.
13350 !   *SAMSPK* indicates that data for U-233/236 spiked samples is in the
13356 !     form of sample-238/spike-233 ratios, not as the raw ratios.
13362 !   *368* indicates that the data for U-233/236 spiked samples is in the
13368 !     form of 233/236 and 233/238 ratios.
13374 !
13380  OPTION BASE 1
13386  COM /Ms/ Ms$(*)
13392  OFF KEY
13398  OFF KBD
13404  Ncols=50    ! number of columns to be converted
13410  Nsamples=0
13416  Escape=0
13422 !
13428  DIM V$[75],Temp$[80],R$[160],Str$(8)[16],Crud$[24],Cat$(40)[80],Row$[450]
13434  DIM Title$[80],L1$[500],L2$[500],Tfile$[25],Drive_string$[15],Pf_file$(50)[10],Rawfile$[15]
13440 !
13446  Clear  ! Clear CRT alpha
13452  OFF KEY
13458  ON KBD GOTO 13566
13464  PRINTER IS CRT
13470  PRINT TABXY(1,4);"Press "&FNH$(" k0 ")&" for a catalog of the disk in the "&FNUn$("left")&"-hand drive.
       "
13476  PRINT TABXY(1,6);"Press "&FNH$(" k1 ")&" for a catalog of the disk in the "&FNUn$("right")&"-hand drive
       "
13482  PRINT TABXY(1,8);"Press "&FNH$(" k4 ")&" to load a Visicalc datafile into memory."
13488  PRINT TABXY(1,10);"Press "&FNH$(" k6 ")&" to print out the datafile data on the printer."
13494  PRINT TABXY(1,12);"Press "&FNH$(" k7 ")&" to cancel k6."
13500  PRINT TABXY(1,14);"Press "&FNH$(" k8 ")&" for HELP."
13506  PRINT TABXY(1,16);"Press "&FNH$(" k9 ")&" to escape."
13512  ON KEY 9 LABEL "    ESCAPE" GOTO Getvc_escape
13518  ON KEY 4 LABEL "LOAD DATAFILE" GOTO Whichfile
13524  ON KEY 0 LABEL "CATALOG Drv #0" GOTO 13686
13530  ON KEY 1 LABEL "CATALOG Drv #1" GOTO 13710
13536  ON KEY 8 LABEL "     HELP" GOTO 13602
13542  ON KEY 7 LABEL " DISPLAY DATA" GOTO 13656
13548  ON KEY 6 LABEL " PRINT DATA" GOTO 13626
13554  GOTO 13554
13560  !
13566  K=FNGet_key
13572  OFF KBD
13578  IF K<>8 THEN
13584    Clunk
13590    GOTO 13452
13596  ELSE
13602    CALL Help12
13608    GOTO 13446
13614  END IF
13620  !
13626  Print=1
13632  BEEP
13638  DISP FNH$(" PRINTOUT DATA ON THE PRINTER ")
```

```
13644  GOTO 13554
13650  !
13656  Print=0
13662  DISP FNH$(" DISPLAY DATA ON CRT ONLY ")
13668  BEEP
13674  GOTO 13554
13680  !
13686  Drive_string$=Ms$(0)
13692  GOTO 13716
13698  !
13704  !
13710  Drive_string$=Ms$(1)
13716  OFF KEY
13722  OFF KBD
13728  Clear  ! Clear CRT alpha
13734  FOR P=1 TO 1+Print
13740    IF P=1 THEN PRINTER IS CRT
13746    IF P=2 THEN PRINTER IS 701
13752    ON ERROR GOTO Bad_cat
13758    S=8
13764    Nfiles=0
13770    DISP "Getting disk catalog..."
13776    CAT Drive_string$ TO Cat$(*)
13782    DISP
13788    OFF ERROR
13794    PRINT TABXY(20,2);FNUn$("VISICALC /PF FILES ON DRIVE #"&Drive_string$[13])
13800    PRINT
13806    LOOP ! determine if file is a VISICALC /PF file (must  end in A and be padded with underscore charact
     ers & be an ASCII file
13812      Tac$=TRIM$(REV$(Cat$(S)[1,10]))
13818    EXIT IF LEN(Tac$)=0
13824      LOOP
13830      EXIT IF Cat$(S)[32,36]()"ASCII" OR Tac$[1,1]()"_"
13836        Tac$=Tac$[2]
13842      END LOOP
13848      IF Tac$[1,1]="A" AND Cat$(S)[32,36]="ASCII" THEN
13854        Nfiles=1+Nfiles
13860        Pf_file$(Nfiles)=REV$(Tac$[2])
13866        PRINT TAB(24);"#"&VAL$(Nfiles);TAB(28);"--  ";Pf_file$(Nfiles)
13867        IF (Nfiles/16)=INT(Nfiles/16) THEN
13869          DISP "PRESS"&FNCt$&"TO SEE MORE FILES..."
13870          BEEP 330,.05
13872          PAUSE
13873          DISP
13875        END IF
13876      END IF
13878      S=S+1
13884    EXIT IF LEN(TRIM$(Cat$(S)))=0 OR S=40
13890    END LOOP
13896    OFF ERROR
13902  NEXT P
13908  PRINTER IS CRT
13914  IF Nfiles=0 THEN
13915    Clear
13920    PRINT TABXY(15,10);FNH$("THERE AREN'T ANY /PF VISICALC FILES ON DISK #"&Drive_string$[13])
13926    DISP "Press"&FNCt$&"when ready..."
13932    PAUSE
13938    GOTO 13446
13944  ELSE
13950    Filenum=0
13956    DISP "ENTER FILE# TO BE LOADED...";
13962    ON KEY 9 LABEL "    ESCAPE" GOTO 13446
13968    ON KBD GOTO 13980
13974    GOTO 13974
```

```
13980    K=FNGet_key
13986    OFF KBD
13992    OFF KEY
13998    IF K<NUM("1") OR K>NUM("9") THEN 13962
14004    OUTPUT KBD;CHR$(K);
14010    DISP Bs$&"   (enter 0 to escape)";
14016    INPUT Filenum
14022    IF Filenum<1 OR Filenum>Nfiles THEN 13446
14028    Temp$=Pf_file$(Filenum)
14034    Clear
14040    GOTO Catfile
14046  END IF
14052  !
14058 Bad_cat:OFF ERROR
14064  DISP FNH$(ERRM$)
14070  Clunk
14076  WAIT 2
14082  GOTO 13446
14088  !
14094 Whichfile:Clear    ! Clear CRT alpha
14100  PRINT USING "9/,K,2/,K";"ENTER THE NAME[:Drive] OF THE VISICALC ASCII-FILE TO BRING INTO MEMORY?","(exa
       mple: Trialfile:1)"
14106  OFF KEY
14112  IF LEN(Rawfile0$) THEN
14118    PRINT TABXY(1,8);"Press"&FNCt$&"for more data from ";FNH$(Rawfile0$)
14124    Temp$=Rawfile0$
14130  END IF
14136 V_kbd:ON KEY 9 LABEL "    ESCAPE" GOTO 13446
14142  ON KBD GOTO 14166
14148  DISP "?"
14154  GOTO 14154
14160 !
14166  K=FNGet_key
14172  OFF KBD
14178  OFF KEY
14184  IF K()-189 THEN     ! (not CONTINUE)
14190    IF K()-171 THEN OUTPUT KBD;CHR$(K);  ! Not CAPS LOCK key
14196    DISP "(enter "&FNH$("*")&" to escape)";
14202    PRINT TABXY(1,8);RPT$(" ",80)
14208    INPUT Temp$
14214  END IF
14220  !
14226 Catfile:OFF KBD
14232  OFF KEY
14238  IF TRIM$(Temp$)="*" THEN 13446
14244  Clear
14250  DISP "Accessing file "&Temp$&"..."
14256  !
14262  LOOP
14268    Colon=POS(Temp$,":")   ! Use colon to separate file-name from drive$
14274  EXIT IF Colon
14280    Temp$=TRIM$(Temp$)&":1"
14286  END LOOP
14292  Rawfile0$=Temp$
14298  ON ERROR GOTO Badspec
14304  Rawfile$=TRIM$(Temp$[1,Colon-1])
14310  L=LEN(Rawfile$)
14316  IF L<10 THEN Rawfile$=Rawfile$&"A"
14322  Drive_number=VAL(Temp$[1+Colon])
14328  Drive_string$=Ms$(Drive_number)
14334  OFF ERROR
14340 !
14346  L=LEN(Rawfile$)
14352  IF L<10 THEN Rawfile$[L+1,10]=RPT$("_",10-L)  ! add underscore characters as fill to be compatible with
        the Visicalc format
```

```
14358  !
14364  Badcount=0
14370 Recoup:ON ERROR GOTO Badfile
14376  Tfile$=Rawfile$&Drive_string$
14382  ASSIGN @P1 TO Tfile$
14388  ENTER @P1;V$
14394  L=LEN(V$)
14400  L=MIN(80,L)
14406  Title$=V$[1,L]   ! first line in the file assumed to be a title-line
14412  Rawfile$=Temp$
14418  GOSUB Nsux
14424  !
14430  LOOP
14436    Row$=""
14442    FOR I=1 TO Nsux
14448      ENTER @P1;V$
14454      Row$=Row$&V$[1+3*(I)1)]
14460    NEXT I
14466  EXIT IF POS(Row$,RPT$("=",Ncols*9))
14472  END LOOP
14478  OFF ERROR
14484 !
14490  Clear     ! Clear CRT alpha
14496  !
14502  Control1=POS(Title$,CHR$(27))      ! Escape-character location -
14508  IF Control1 THEN                   ! trim printer-control code if present
14514    Control2=POS(Title$[Control1]," ")! end of  control-sequence
14520    IF Control2 THEN Title$=Title$[1,Control1-1]&Title$[Control2]
14526  END IF
14532  PRINT USING "K,/,K,6X,K,/";Title$,"SET#","NAME"
14538  !
14544 Get_data:MAT Raw= (0)
14550  Row=0
14556  ON KEY 9 LABEL "    ESCAPE" GOTO Done
14562  LOOP
14568    ON ERROR GOTO Done
14574    Row$=""
14580    FOR I=1 TO Nsux
14586      ENTER @P1;V$
14592      Row$=Row$&V$[1+3*(I)1)]
14598    NEXT I
14604    OFF ERROR
14610    Row=1+Row
14616    Name$(Row)=TRIM$(Row$[1,18]) ! row-names in 1st 2 columns (A and B)
14622    PRINT Row;TAB(6);Name$(Row)
14628    FOR Col=3 TO 50
14634      Rcol=Col-2
14640      ON ERROR GOTO 14658
14646      Raw(Row,Rcol)=VAL(Row$[9*Col-8,9*Col])    ! extract numeric value
14652      DISP Name$(Row),Row;Rcol,Raw(Row,Rcol)
14658      OFF ERROR
14664    NEXT Col
14670  END LOOP
14676  !
14682 Done:OFF ERROR  ! got all data, printout or display values
14688  OFF KEY
14694  ASSIGN @P1 TO *
14700  Clear  ! Clear CRT alpha
14706  Dfile=(Row)0)
14712  IF Print THEN
14718    PRINTER IS 701
14724    PRINT USING "K,/,K,6X,K,/";Title$,"SET#","NAME"
14730    FOR I=1 TO Row
14736      PRINT I;TAB(6);Name$(I)
```

```
14742    NEXT I
14748    PRINT USING "B/"
14754    PRINTER IS CRT
14760    DISP "PRESS"&FNCt$&"WHEN READY TO CONTINUE..."
14766    PAUSE
14772  END IF
14778  Nsamples=Row
14784  SUBEXIT
14790  !
14796 Nsux: ! How many sucks needed to get a row
14802  Nsux=1
14808  Row$=V$              ! String for whole row
14814  IF LEN(V$)=72 THEN   ! Is 72 only if more characters in row
14820    LOOP               ! Get more of the row-string
14826      ENTER @P1;V$
14832      Nsux=1+Nsux      ! number of "sucks" required to get all of row
14838      L=LEN(V$)
14844      Row$=Row$&V$[4] ! Eliminate the 1st three "pad" blanks
14850    EXIT IF L<75       ! Last string if not 75
14856    END LOOP
14862  END IF
14868  Ncols=INT(LEN(Row$))/9
14874  RETURN
14880  !
14886 Badfile:Badcount=1+Badcount
14892  IF Badcount<7 THEN
14898    IF Badcount=3 THEN Rawfile$=UPC$(Rawfile$)
14904    IF Badcount=5 THEN Rawfile$=LWC$(Rawfile$)
14910    Drive_string$[13,13]=VAL$(NOT (VAL(Drive_string$[13,13])))
14916    GOTO Recoup
14922  END IF
14928  Rawfile0$=""
14934  DISP USING "12X,K";CHR$(131)&"  **** CAN'T ACCESS FILE "&Temp$&" ****  "&CHR$(128)
14940  Clunk
14946  WAIT 3
14952  GOTO Vcfile
14958  !
14964 Badspec:Bad_input("INVALID FILE OR MASS-STORAGE SPECIFIER")
14970  Rawfile0$=""
14976  GOTO Whichfile
14982  !
14988 No_colnames:Clear  ! Clear CRT alpha
14994  OFF ERROR
15000  PRINT USING "6/,K,/,K,/";FNH$("**** CAN'T FIND REPEATING-EQUALS LINE (=========...) THAT MUST UNDERLIE
       THE          COLUMN-NAMES ****")
15006  Clunk
15012  WAIT 5
15018  GOTO Vcfile
15024  !
15030 Getvc_escape:Clear
15036  Escape=1
15042 SUBEND
15048 !
15054 !
15060 Whoop:SUB Whoop
15066  FOR I=100 TO 3000 STEP 200
15072    BEEP I,.01
15078  NEXT I
15084 SUBEND
15090 !
15096 !
15102 Storefile:SUB Storefile(Name$(*),Red(*),Firstsample,Lastsample)
15108  ! Subprogram to create and store a VISICALC PF file from the
15114  ! reduced-data array.
```

```
15120  !
15126  OPTION BASE 1
15132  COM /Ms/ Ms$(*)
15138  DIM Rawstring$[378],Cname1$[378],Cname2$[378],C1$[9],C2$[9],File$[15],Temp$[24],Table$[80],File0$[10]
15144  OFF KEY
15150  OFF KBD
15156  Nred=Lastsample-Firstsample+1
15162  !
15168 Filename:File$=""
15174  PRINT USING "3/,K,2/,K";"IF YOU WANT TO STORE THIS DATA AS A REDUCED-DATA FILE, ENTER THE FILE NAME.","
       OTHERWISE, JUST PRESS "&FNCt$&"."
15180  INPUT File$
15186  IF File$="" OR File$="*" THEN SUBEXIT
15192  !
15198  PRINT File$
15204  P=POS(File$,":")
15210  IF P THEN File$=File$[1,P-1]   ! In case user included MSUS
15216  File0$=TRIM$(File$[1,10])
15222  LOOP
15228    PRINT USING "/,K";"WHICH DISK-DRIVE (0 or 1)?"
15234    INPUT D
15240    PRINT D
15246  EXIT IF D=0 OR D=1
15252    Clunk
15258  END LOOP
15264  !
15270  PRINT USING "/,K";"ENTER A TITLE FOR THE REDUCED-DATA FILE:"
15276  LINPUT Table$
15282  PRINT Table$
15288  !
15294 Create_file:ON ERROR GOTO Purge
15300  Clear
15306  DISP "Checking disk..."
15312  L=LEN(File0$)
15318  IF L>9 THEN File$=File0$[1,9]
15324  IF L<=9 THEN File$=File0$
15330  File$=File0$&"A"
15336  IF L<9 THEN File$=File$&RPT$(" ",9-L)
15342  CREATE BDAT File$&Ms$(D),INT((1600+400*Nred)/256)+1
15348  DISP
15354  OFF ERROR
15360  !
15366  ASSIGN @N1 TO File$&Ms$(D)
15372  Clear
15378  PRINT TABXY(1,10);FNCenter$("CREATING REDUCED-DATA FILE....")
15384  !
15390  ! Column-headings
15396  DATA "","   SAMPLE","","  NAME","  SAMPLE","  WT. (g)","","  ppm U","","  ppm Th","","  ppm Pb","COMMON-Pb","
         ppm","  Pb-206/g","  nanomoles"
15402  DATA "  206/204","  (raw)","  206/204","  (corr.)","  207/204","  (corr.)","  208/204","  (corr.)","  206/238",
       "  (rad.)","  207/235","  (rad.)"
15408  DATA "  207/206","  (rad.)","  208/232","  (rad.)","  206/238","  age (Ma)","  207/235","  age (Ma)","  207/206"
       "  age (Ma)","  208/232","  age (Ma)"
15414  DATA "","  238/204","","  235/204","","  232/204","  [U]","  Zerr","  [Th]","  Zerr","  [204]","  Zerr","
        [206]","  Zerr"
15420  DATA "  206/204","  Zerr","  207/204","  Zerr","  208/204","  Zerr","  6/4-7/4","   Rho","  6/4-8/4","   Rho
       ","  206/238","  Zerr","  207/235","  Zerr"
15426  DATA "  207/206","  Zerr","  6/8-7/5","   Rho","  208/232","  Zerr","  238/204","  Zerr","  232/204","  Zerr
       ","Mu-Alpha","  Rho","Mu-Beta","  Rho"
15432  DATA "Th4-Gamma","  Rho","  BETA","  eU/U","  GAMMA","  eU/U","  BETA/","  GAMMA"
15438 !DATA "  BETA","  eU/U","  GAMMA","  eU/U","  BETA/","  GAMMA"
15444  !
15450 Construct_file:Cname1$[1,378]=""
15456  Cname2$[1,378]=""
```

```
15462  RESTORE 15396
15468  FOR I=1 TO 42                          ! create the two column-heading rows
15474    S1=9*I-8
15480    S2=S1+8
15486    READ C1$,C2$
15492    Cname1$[S1,S2]=C1$
15498    Cname2$[S1,S2]=C2$
15504  NEXT I
15510  !
15516  Rowlength=378
15522  ASSIGN @N1 TO File$&Ms$(D)
15528  L=LEN(Table$)
15534  OUTPUT @N1;Table$&RPT$(" ",378-L)
15540  OUTPUT @N1;" "
15546  OUTPUT @N1;Cname1$[1,Rowlength]
15552  OUTPUT @N1;Cname2$[1,Rowlength]
15558  OUTPUT @N1;RPT$("=",Rowlength)
15564  !
15570  FOR I=Firstsample TO Lastsample
15576    ! Add the sample names and reduced-data values
15582    Rowstring$[1,Rowlength]=""
15588    Rowstring$[1,18]=Name$(I)
15594    FOR J=1 TO 40
15600      S1=9*(J+2)-8
15606      S2=S1+8
15612      Temp$=VAL$(Red(I,J))
15618      Rowstring$[S1,S2]=Temp$[1,9]
15624    NEXT J
15630    DISP USING "3D,8X,K";I-Firstsample+1,Name$(I)
15636    OUTPUT @N1;Rowstring$
15642  NEXT I
15648  DISP
15654  Clear
15660  PRINT TABXY(1,10);FNCenter$("FILE  "&CHR$(34)&File0$&CHR$(34)&"  STORED.")
15666  Whoop
15672  WAIT 2
15678  SUBEXIT
15684  !
15690  Purge:IF ERRN=54 THEN      ! purge file if already exists
15696    DISP "FILE "&CHR$(34)&File0$&CHR$(34)&" ALREADY EXISTS.  OVERWRITE (1)  OR PICK ANOTHER NAME (2)";
15702    INPUT Q
15708    DISP
15714    SELECT Q
15720    CASE 1
15726      PURGE File$&Ms$(D)
15732      GOTO Create_file
15738    CASE 2
15744      DISP
15750      GOTO Filename
15756    CASE ELSE
15762      Clunk
15768      GOTO Purge
15774    END SELECT
15780  ELSE
15786    Clear
15792    PRINT TABXY(1,14);FNCenter$(FNH$("UNABLE TO CREATE FILE ON SPECIFIED DISK"))
15798    PRINT TABXY(1,16);FNCenter$("REPLACE DISK AND PRESS"&FNCt$)
15804    Clunk
15810    PAUSE
15816    GOTO Create_file
15822  END IF
15828  SUBEND
15834  !
15840  !
```

```
15846 Help1:SUB Help1 ! HELP screen for starting-display
15852  OPTION BASE 1
15858  DIM S$(14)[160]
15864  DATA k0: CHANGE Pb0       Change the initial-Pb isotope ratios and errors to be used for reduction of ra
       w data from a datafile.$
15870  DATA"k1: Pb-208 SPIKED    Raw data to be entered is for samples that were spiked with a Pb-208 spike, ra
       ther than a Pb-205 mixed Pb-U-Th spike.$"
15876  DATA k2: U-235 SPIKED     Raw data to be entered is for samples that were spiked with a Pb-208 and a U-2
       35(/Th-230) spike rather than a
15882  DATA mixed U-233/U-236 spike.$
15888  DATA"k3: LABDATA          Invoke the LABDATA functions of the program, so that you can modify, create, o
       r change the LABDATA files.  A LABDATA file"
15894  DATA"contains spike, mass-discrimination, and blank data for a particular lab or method of data-accumul
       ation.$"
15900  DATA k4: DATAFILE         Enter the raw data from a VISICALC-created datafile rather than by typing in t
       he raw data from the keyboard.$
15906  DATA"k5: USE PRINTER      Printout the reduced data on the printer, rather than just the CRT.$"
15912  DATA"k6: Pb-205 SPIKED    Raw data to be entered is for samples that were spiked with a mixed Pb-205/U/T
       h-230 spike, rather than a Pb-208 spike."
15918  DATA The data stored for the Pb-205 spike determines whether the U in the spike is assumed to be U-235
       or U-233/U-236.  The default format assumes that
15924  DATA "you already know the sample-238/spike-233 ratio.  If this is not true, then press SHIFT-k7 to c
       hange this assumption.$"
15930  DATA k7: U-233 SPIKED     Raw data to be entered is for samples that were spiked with a Pb-208 spike and
        a mixed U-233/U-236 spike rather than a
15936  DATA "U-235(/Th-230) spike.  The default format assumes that you already know the sample-238/spike-233
       ratio.  If this is not true,"
15942  DATA " then you must press SHIFT-k7 to change this assumption.$"
15948  DATA"k9: KEYBOARD         Enter the raw data by typing it in from the keyboard, rather than getting it f
       rom a datafile."
15954  !
15960  READ S$(*)
15966  Helpscreen(S$(*),21,1)
15972 SUBEND
15978 !
15984 !
15990 Helpscreen:SUB Helpscreen(Input_string$(*),Indent,Keyhelp)
15996 ! prints out a message on the CRT with linefeeds at appropriate breaks
16002 ! between words.  Also inserts one linefeed for each $ symbol, and in-
16008 ! dents each line after a linefeed by Indent spaces.  Tricky, huh?
16014 !
16020  DIM Largestring$[2400],Linestring$[80],Substring$[2400],Revstring$[80]
16026 !
16032  Clear  ! Clear CRT alpha
16038  OFF KEY
16044  OFF KBD
16050  OFF KNOB
16056  PRINTER IS CRT
16062  GRAPHICS OFF
16068  IF Keyhelp THEN
16074    PRINT USING " 16X,K,/";FNH$(" FUNCTIONS OF KEYS DEFINED DURING LAST DISPLAY: ")
16080    PRINT USING "K,/";FNUn$("KEY")&"    "&FNUn$("LABEL")&"                    "&FNUn$("FUNCTION")
16086  END IF
16092  Largestring$=""
16098  ! build a single large string out of the input-string array
16104  FOR I=1 TO SIZE(Input_string$,1)
16110    Largestring$=Largestring$&TRIM$(Input_string$(I))&" "
16116  NEXT I
16122  Maxlen=80
16128 !
16134  Nlines=5*Keyhelp ! starting-line of HELP minus one.
16140  Firstscreen=1    ! First screen of this HELP?
16146  Firstline=1      ! Indicates not an indented line
16152  !
```

```
16158  LOOP
16164  EXIT IF LEN(TRIM$(Largestring$))=0
16170    Maxlen=80-Indent*(Firstline=0)       ! Max. permissible length, not
16176    Maxlen=MIN(Maxlen,LEN(Largestring$)) !  including indentation.
16182    Lf=POS(Largestring$,"$")
16188    IF Lf=1 THEN          ! If first character is a linefeed token, then
16194      PRINT               !  print a blank line & strip the token.
16200      Nlines=1+Nlines     ! Increment line# counter.
16206      Firstline=1         ! Next line not to be indented.
16212      IF Largestring$="$" THEN Done
16218      Largestring$=Largestring$[2] ! Strip linefeed token.
16224    ELSE                  ! First character not a linefeed token.
16230      Next_lf=POS(Largestring$,"$")  ! Position of next linefeed token.
16236      IF Next_lf THEN               ! Substring to next linefeed token.
16242        Substring$=Largestring$[1,Next_lf-1]
16248      ELSE
16254        Substring$=Largestring$
16260      END IF
16266      IF LEN(Substring$)<=Maxlen THEN   ! Don't need to find wordbreak.
16272        IF Indent AND NOT Firstline THEN PRINT TAB(Indent); ! Indent line.
16278        PRINT TRIM$(Substring$)
16284        Firstline=0
16290        Nlines=1+Nlines
16296        ! Strip last printed line from total string.
16302        IF LEN(Substring$)<=LEN(Largestring$) THEN Largestring$=Largestring$[1+LEN(Substring$)]
16308      ELSE
16314        Linestring$=Largestring$[1,Maxlen] ! Fragment that can fit on line.
16320        Revstring$=REV$(Linestring$)       ! Reverse-string.
16326        REPEAT                            ! Don't include any linefeed tokens
16332          Lf=POS(Revstring$,"$")
16338          IF Lf THEN Revstring$=Revstring$[2]
16344        UNTIL Lf=0
16350        S=POS(Revstring$," ")             ! Find wordbreak position
16356        IF S THEN Revstring$=Revstring$[1+S] ! Goto wordbreak position.
16362        Lrev=LEN(Revstring$)
16368        IF Indent AND NOT Firstline THEN PRINT TAB(Indent); ! Indent line.
16374        PRINT TRIM$(REV$(Revstring$))
16380        Nlines=1+Nlines                   ! Increment line#-counter
16386        IF LEN(Largestring$))=Lrev THEN Largestring$=Largestring$[Lrev+1]
16392        Firstline=0                       ! Next line will be indented.
16398      END IF
16404      IF Nlines)=16 THEN                  ! Pause for user to read.
16410        DISP "Press"&FNCt$&"for more HELP...";
16416        IF NOT Firstscreen THEN
16422          DISP RPT$(CHR$(8),3)&",  Roll screen with "&FNH$("KNOB")
16428        ELSE
16434          DISP
16440        END IF
16446        Firstscreen=0
16452        Nlines=0
16458        PAUSE
16464      END IF
16470    END IF
16476  END LOOP
16482    !
16488 Done:DISP "Roll screen with "&FNH$("KNOB")&",  press"&FNCt$&"to return..."
16494  PAUSE
16500 SUBEND
16506 !
16512 !
16518 Printer_timeout:SUB Printer_timeout
16524  COM /Print/ Printer_ok
16530  OFF TIMEOUT
16536  OFF KEY
```

```
16542  OFF KBD
16548  Printer_ok=0
16554  PRINTER IS CRT
16560  Clear
16566  PRINT TABXY(1,12);FNCenter$(FNH$("*** PRINTER DOES NOT RESPOND ***"))
16572  Beeper(50,1200,.03,.01)
16578 SUBEND
16584!
16590!
16596 Beeper:SUB Beeper(Ncycles,Hertz,Beep_time,Wait_time)
16602  FOR I=1 TO Ncycles
16608    BEEP Hertz,Beep_time
16614    WAIT Wait_time
16620  NEXT I
16626 SUBEND
16632 !
16638 !
16644 Stacey_kramers:SUB Stacey_kramers(Age,R64,R74,R84)
16650  ! Calculate the Stacey-Kramers model lead for a given age.
16656  ! (Stacey and Kramers, Earth & Planetary Science Letters v. 26, p. 207-221, 1975)
16662  !
16668  DATA .155125E-3,.98485E-3,.049475E-3,137.88,3700,11.152,12.998,31.230,9.74,36.84
16674  READ Lambda238,Lambda235,Lambda232,R238_235,T0,R640,R740,R840,Mu,Th232_pb204
16680  !
16686  R64=DROUND(R640+Mu*(EXP(Lambda238*T0)-EXP(Lambda238*Age)),5)
16692  R74=DROUND(R740+Mu/R238_235*(EXP(Lambda235*T0)-EXP(Lambda235*Age)),5)
16698  R84=DROUND(R840+Th232_pb204*(EXP(Lambda232*T0)-EXP(Lambda232*Age)),5)
16704 SUBEND
16710  !
16716  !
16722 Help2:SUB Help2(Param) ! HELP screen for Pb-208 spiked WEIGHTS form
16728  OPTION BASE 1
16734  DIM S$(3)[160]
16740  SELECT Param
16746  CASE 1
16752    RESTORE 16758
16758    DATA "$$$$$$$$$The SAMPLE NAME is the name to be assigned to this sample."
16764    N=1
16770  CASE 3
16776    RESTORE 16782
16782    DATA "$$$$$$$$$The SAMPLE WEIGHT is the weight of the sample (in grams) that was attacked and disso
       lved."
16788    N=1
16794  CASE 5
16800    RESTORE 16806
16806    DATA "$$$$$$The TOTAL-ALIQUOT WEIGHT is the weight (in grams), of the solution containing all of
       the dissolved sample, before any aliquoting.$"
16812    DATA "If the TOTAL ALIQUOT is simply the sum of the spiked and unspiked aliquots, though,"
16818    DATA "you needn't enter a value for the TOTAL ALIQUOT WEIGHT."
16824    N=3
16830  CASE 6
16836    RESTORE 16842
16842    DATA "$$$$$$$The Pb-UNSPIKED ALIQUOT WEIGHT is the weight (in grams) of the solution aliquot that w
       as NOT spiked with a Pb-spike."
16848    N=1
16854  CASE 7
16860    RESTORE 16866
16866    DATA"$$$$$$$The Pb-SPIKED ALIQUOT WEIGHT is the weight (in grams) of the solution aliquot that was
        spiked with a Pb-spike."
16872    N=1
16878  CASE 9
16884    RESTORE 16890
16890    DATA "$$$$$$If the solution aliquot that was spiked for Uranium and/or Therium was the TOTAL ALIQUOT
       , enter a 1 for this parameter.$"
```

```
16896    DATA "  If the Uranium and/or Thorium - spiked aliquot was the same aliquot as the Pb-SPIKED ALIQUOT
     , enter a 2 for this parameter."
16902    N=2
16908  CASE 11
16914    RESTORE 16920
16920    DATA "$$$$$$$Enter the grams of Pb-spike delivered to the Pb-Spiked Aliquot."
16926    N=1
16932  CASE 12
16938    RESTORE 16944
16944    DATA "$$$$$$$Enter the grams of Uranium-spike delivered to the Uranium(Thorium)-spiked aliquot.  If t
     he Uranium spike is a mixed-spike, you must still"
16950    DATA "enter a value here."
16956    N=2
16962  CASE 13
16968    RESTORE 16974
16974    DATA "$$$$$$$Enter the grams of Thorium-spike delivered to the Uranium(Thrium)-spiked aliquot.  If th
     e Thorium spike is a mixed-spike, you must"
16980    DATA "still enter a value here."
16986    N=2
16992  END SELECT
16998  !
17004  REDIM S$(N)
17010  READ S$(*)
17016  Helpscreen(S$(*),0,0)
17022 SUBEND ! ----------------------------------------------------------------
17028 !
17034 !
17040 Help3:SUB Help3(Param) ! HELP screen for 205-spiked WEIGHTS form
17046  OPTION BASE 1
17052  DIM S$(1)[160]
17058  SELECT Param
17064  CASE 4
17070    DATA "$$$$$$$$$The SAMPLE NAME is the name to be assigned to this sample."
17076    RESTORE 17070
17082  CASE 6
17088    RESTORE 17094
17094    DATA "$$$$$$$$$The SAMPLE WEIGHT is the weight of the sample (in grams) that was attacked and disso
     lved."
17100  CASE 8
17106    RESTORE 17112
17112    DATA "$$$$$$Enter the amount (in grams) of the mixed Pb-205/U-235/Th-230 spike delivered to the sampl
     e.  Total spiking is assumed."
17118  END SELECT
17124  READ S$(*)
17130  Helpscreen(S$(*),0,0)
17136 SUBEND
17142  !
17148  !
17154 Help4:SUB Help4(Param) ! HELP screen for 208-spiked Pb-unspiked FORM
17160  OPTION BASE 1
17166  DIM S$(2)[160]
17172  SELECT Param
17178  CASE 3
17184    RESTORE 17190
17190    DATA "$$$$$Enter the raw 206/204 ratio of the Pb-unspiked aliquot.  This is the ratio directly from
      the mass-spectrometer (no fractionation"
17196    DATA correction applied).
17202    N=2
17208  CASE 4
17214    RESTORE 17220
17220    DATA "$$$$$$Enter the uncertainty in the measured 206/204 ratio of the Pb-unspiked aliquot.  Enter
     the value in percent and at the 95%-confidence"
17226    DATA or 2-sigma level.
17232    N=2
```

```
17238  CASE 6
17244    RESTORE 17250
17250    DATA "$$$$$Enter the raw 206/207 ratio of the Pb-unspiked aliquot.  This is the ratio directly from
       the mass-spectrometer (no fractionation"
17256    DATA correction applied).
17262    N=2
17268  CASE 7
17274    RESTORE 17280
17280    DATA "$$$$$$Enter the uncertainty in the measured 206/207 ratio of the Pb-unspiked aliquot.  Enter
      the value in percent and at the 95%-confidence"
17286    DATA or 2-sigma level.
17292    N=2
17298  CASE 9
17304    RESTORE 17310
17310    DATA "$$$$$Enter the raw 206/208 ratio of the Pb-unspiked aliquot.  This is the ratio directly from
       the mass-spectrometer (no fractionation"
17316    DATA correction applied).
17322    N=2
17328  CASE 10
17334    RESTORE 17340
17340    DATA "$$$$$$Enter the uncertainty in the measured 206/208 ratio of the Pb-unspiked aliquot.  Enter
      the value in percent and at the 95%-confidence"
17346    DATA or 2-sigma level.
17352    N=2
17358  CASE 12
17364    RESTORE 17370
17370    DATA "$$$$$Enter the estimated Pb blank, in nanograms.  This is the blank that applies to the Pb-unsp
      iked aliquot, not the total sample."
17376    N=1
17382  END SELECT
17388  REDIM S$(N)
17394  READ S$(*)
17400  Helpscreen(S$(*),0,0)
17406 SUBEND
17412 !
17418 !
17424 Help5:SUB Help5(Param) ! HELP screen for 208-spiked Pb-spiked FORM
17430  OPTION BASE 1
17436  DIM S$(2)[160]
17442  SELECT Param
17448  CASE 3
17454    RESTORE 17460
17460    DATA "$$$$$Enter the raw 206/204 ratio of the Pb-spiked aliquot.  This is the ratio directly from t
      he mass-spectrometer (no fractionation"
17466    DATA correction applied).
17472    N=2
17478  CASE 4
17484    RESTORE 17490
17490    DATA "$$$$$$Enter the uncertainty in the measured 206/204 ratio of the Pb-spiked aliquot.  Enter th
      e value in percent and at the 95%-confidence"
17496    DATA or 2-sigma level.
17502    N=2
17508  CASE 6
17514    RESTORE 17520
17520    DATA "$$$$$Enter the raw 206/207 ratio of the Pb-spiked aliquot.  This is the ratio directly from t
      he mass-spectrometer (no fractionation"
17526    DATA correction applied).
17532    N=2
17538  CASE 7
17544    RESTORE 17550
17550    DATA "$$$$$$Enter the uncertainty in the measured 206/207 ratio of the Pb-spiked aliquot.  Enter th
      e value in percent and at the 95%-confidence"
17556    DATA or 2-sigma level.
17562    N=2
```

```
17568  CASE 9
17574    RESTORE 17580
17580    DATA "$$$$$Enter the raw 206/208 ratio of the Pb-spiked aliquot.  This is the ratio directly from t
       he mass-spectrometer (no fractionation"
17586    DATA correction applied).
17592    N=2
17598  CASE 10
17604    RESTORE 17610
17610    DATA "$$$$$$Enter the uncertainty in the measured 206/208 ratio of the Pb-spiked aliquot.  Enter th
       e value in percent and at the 95%-confidence"
17616    DATA or 2-sigma level.
17622    N=2
17628  CASE 12
17634    RESTORE 17640
17640    DATA "$$$$$Enter the estimated Pb blank, in nanograms.  This is the blank that applies to the Pb-spik
       ed aliquot, not the total sample."
17646    N=1
17652  END SELECT
17658  REDIM S$(N)
17664  READ S$(*)
17670  Helpscreen(S$(*),0,0)
17676 SUBEND
17682 !
17688 !
17694 Help6:SUB Help6(Param)  ! HELP screen for 205-spiked Pb ratios
17700  OPTION BASE 1
17706  N=1
17712  DIM S$(2)[160]
17718  SELECT Param
17724  CASE 3
17730    RESTORE 17736
17736    DATA "$$$$$Enter the raw 206/204 ratio.  This is the ratio directly from the mass-spectrometer (no fr
       actionation correction applied."
17742  CASE 4
17748    RESTORE 17754
17754    DATA "$$$$$$Enter the uncertainty in the measured 206/204 ratio.  Enter the value in percent and at
        the 95%-confidence or 2-sigma level."
17760  CASE 6
17766    RESTORE 17772
17772    DATA "$$$$$Enter the raw 206/207 ratio.  This is the ratio directly from the mass-spectrometer (no fr
       actionation correction applied)."
17778  CASE 7
17784    RESTORE 17790
17790    DATA "$$$$$$Enter the uncertainty in the measured 206/207 ratio.  Enter the value in percent and at
        the 95%-confidence or 2-sigma level."
17796  CASE 9
17802    RESTORE 17808
17808    DATA "$$$$$Enter the raw 206/208 ratio.  This is the ratio directly from the mass-spectrometer (no fr
       actionation correction applied)."
17814  CASE 10
17820    RESTORE 17826
17826    DATA "$$$$$$Enter the uncertainty in the measured 206/208 ratio.  Enter the value in percent and at
        the 95%-confidence or 2-sigma level."
17832  CASE 12
17838    RESTORE 17844
17844    DATA "$$$$$Enter the raw 206/205 ratio.  This is the ratio directly from the mass-spectrometer (no fr
       actionation correction applied)."
17850  CASE 13
17856    DATA "$$$$$$Enter the uncertainty in the measured 206/205 ratio.  Enter the value in percent and at
        the 95%-confidence or 2-sigma level."
17862    RESTORE 17856
17868    RESTORE 17874
17874    DATA "$$$$$Enter the estimated Pb blank, in nanograms.  This is the blank that applies to the fractio
       n actually loaded on the filament."
```

```
17880  END SELECT
17886  REDIM S$(N)
17892  READ S$(*)
17898  Helpscreen(S$(*),0,0)
17904 SUBEND
17910 !
17916 !
17922 Help7:SUB Help7(Param)  ! HELP screen for 235-spiked U-ratios FORM
17928  OPTION BASE 1
17934  DIM S$(1)[160]
17940  SELECT Param
17946  CASE 6
17952    RESTORE 17958
17958    DATA "$$$$$$$Enter the raw 238/235 ratio (no fractionation-correction applied) from the U-spiked aliq
       uot."
17964  CASE 7
17970    RESTORE 17976
17976    DATA "$$$$$$$$Enter the uncertainty, in percent and at the 2-sigma or 95%-confidence level, of the
       raw 238/235 ratio."
17982  CASE 9
17988    RESTORE 17994
17994    DATA "$$$$$$$Enter the raw 232/230 ratio (no fractionation-correction applied) from the Th-spiked ali
       quot."
18000  CASE 10
18006    RESTORE 18012
18012    DATA "$$$$$$$$Enter the uncertainty, in percent and at the 2-sigma or 95%-confidence level, of the
       raw 232/230 ratio."
18018  CASE 12
18024    RESTORE 18030
18030    DATA "$$$$$$$$$Enter the estimated uranium blank, in nanograms, that applies to the uranium-spiked al
       iquot."
18036  CASE 13
18042    RESTORE 18048
18048    DATA "$$$$$$$$$Enter the estimated thorium blank, in nanograms, that applies to the thorium-spiked al
       iquot."
18054  END SELECT
18060  READ S$(*)
18066  Helpscreen(S$(*),0,0)
18072 SUBEND
18078 !
18084 !
18090 Help8:SUB Help8(Param)  ! HELP screen for 233/236-spiked U FORM
18096  OPTION BASE 1          !  with SAM/SPK ratio known.
18102  DIM S$(1)[160]
18108  SELECT Param
18114  CASE 6
18120    RESTORE 18126
18126    DATA "$$$$$$$Enter the Sample-238/Spike-233 ratio, as printed out by  ANALYST  in the mass-spectrome
       ter data printout."
18132  CASE 7
18138    RESTORE 18144
18144    DATA "$$$$$$$$Enter the uncertainty, in percent and at the 2-sigma or 95%-confidence level, of the
       Sample-Spike ratio (from ANALYST's printout)."
18150  CASE 9
18156    RESTORE 18162
18162    DATA "$$$$$$$Enter the raw 232/230 ratio (no fractionation-correction applied) from the Th-spiked ali
       quot."
18168  CASE 10
18174    RESTORE 18180
18180    DATA "$$$$$$$$Enter the uncertainty, in percent and at the 2-sigma or 95%-confidence level, of the
       raw 232/230 ratio."
18186  CASE 12
18192    RESTORE 18198
18198    DATA "$$$$$$$$$Enter the estimated uranium blank, in nanograms, that applies to the uranium-spiked al
       iquot."
```

```
18204  CASE 13
18210    RESTORE 18216
18216    DATA "$$$$$$$$$Enter the estimated thorium blank, in nanograms, that applies to the thorium-spiked al
       iquot."
18222  END SELECT
18228  READ S$(*)
18234  Helpscreen(S$(*),0,0)
18240 SUBEND
18246 !
18252 !
18258 Help10:SUB Help10  ! HELP screen for INITIAL-Pb ratios FORM
18264  OPTION BASE 1
18270  DIM S$(13)[160]
18276  DATA "The INITIAL Pb is the Pb that was present in the mineral or rock at the time of its formation.
        This is distinct from the laboratory"
18282  DATA "Blank-Pb.  Enter your estimated values for the 206/204, 207/204, and 208/204 of the Initial Pb
       .$The errors that the form is asking you for"
18288  DATA "are the estimated uncertainties (errors) in the above ratios.  Note that these errors are to be e
       ntered in absolute terms, not"
18294  DATA "in percent!  As usual, enter the errors at the 2-sigma or 95%-confidence level.$The 206/204-207
       /204 error correlation is generally pretty"
18300  DATA "high -- if you don't know how to calculate the correlation, try a value of 0.9.  Or try the formu
       la$"
18306  DATA "Rho = (E(6/4)^2 + E(7/4)^2 - E(6/7)^2)/(2*E(6/4)*E(7/4))$where Rho is the 6/4-7/4 error-correlati
       on, and E(6/4), E(7/4), E(6/7) are the"
18312  DATA "errors in the initial-Pb 206/204, 207/204, and 206/207, respectively.$"
18318  DATA "If you want the program to calculate the standard Stacey-Kramers model Pb for a particular age, j
       ust enter that age and press  EXECUTE ."
18324  DATA "The program will insert the proper values in the FORM for you to examine and edit.  Press  EXECU
       TE  again to accept the values."
18330  DATA "$As a final note, if you intend to pool data for this analysis with"
18336  DATA "several others for a regression line on the Concordia diagram, enter zeroes for the errors if y
       ou think that all of the samples have"
18342  DATA "shared the same initial-Pb.  Only enter nonzero values if you are not pooling data for seve
       ral samples, or if you think that"
18348  DATA"the samples really did have different initial-Pb ratios."
18354  READ S$(*)
18360  Helpscreen(S$(*),0,0)
18366 SUBEND
18372  !
18378  !
18384 Ct:DEF FNCt$
18390  RETURN " "&FNH$("CONTINUE")&" "
18396 FNEND
18402 !
18408 !
18414 Help11:SUB Help11  ! HELP screen for LABDATA files.
18420  OPTION BASE 1
18426  DIM S$(12)[160]
18432  DATA "$$$$$$$$A LABDATA file is a file on a disk that contains information specific to your laborator
       y.$This information includes the concentrations"
18438  DATA"and isotope ratios your Pb, U, and Th spikes, your estimated blank-Pb ratios, the uncertainties in
        your assigned blanks, and what the typical"
18444  DATA "mass-fractionation values (in percent per mass- unit) are for your typical mass-spectrometer runs
       ."
18450  REDIM S$(3)
18456  READ S$(*)
18462  Helpscreen(S$(*),0,0)
18468  !
18474  DATA "k0: U233 Spike      Define or redefine isotope ratios and concentrations for a U-233/U-236 mixed
       spike.$"
18480  DATA "k1: Pb208 Spike     Define or redefine isotope ratios and concentrations for a Pb-208 spike.$"
18486  DATA "k2: Pb205 Spike     Define or redefine isotope ratios and concentrations for a Pb-205/U-235/Th-23
       0 mixed spike.$"
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18492 DATA "k3: U235 Spike      Define or redefine isotope ratios and concentrations for a U-235 spike.$"
18498 DATA "k4: Th230 Spike     Define or redefine isotope ratios and concentrations for a Th-230 spike.$"
18504 DATA "k5: Mass Discr      Define typical amounts of mass-discrimination, in percent per mass-unit, to b
      e expected for typical mass- spectrometer runs"
18510 DATA "for Pb, U, and Th (together with uncertainties in your estimates)."
18516 DATA "$k6: Blanks          Define typical isotope ratios for Pb blanks, together with uncertainties in
      both these ratios and in your estimated Pb,"
18522 DATA "U, and Th asssigned blanks.$k7: Store File      Store the currently-defined (including any recent
       edits) LABDATA file on disk.$"
18528 DATA " L                  Bring a different LABDATA file into memory.$ P                    Printout
      or display the information in the current LABDATA"
18534 DATA "File.$ N                  Define a completely new LABDATA file and store it on the disk."
18540 DATA "$ R                 Change the name of the LABDATA file currently in use."
18546 !
18552 REDIM S$(12)
18558 READ S$(*)
18564 Helpscreen(S$(*),21,1)
18570 SUBEND
18576 !
18582 DEF FNBs$
18588  RETURN RPT$(CHR$(8),3)
18594 FNEND
18600 !
18606 !
18612 Help12:SUB Help12   !   ! HELP screen for accessing raw-data files.
18618  OPTION BASE 1
18624 DIM S$(13)[160]
18630 REDIM S$(3)
18636 DATA "k0: CATALOG Drv#0   Display a catalog of the disk in the left-hand drive.$k1: CATALOG Drv#1   Dis
      play a catalog of the disk in the"
18642 DATA "right-hand drive.$k6: PRINT DATA      Print out any disk-catalogs requested, and also the sample
      names of any datafile loaded into memory.$"
18648 DATA "k7: DISPLAY DATA    Cancel k6 (use CRT only).$k4: LOAD DATAFILE   Load a raw-data file (from the
      VISICALC program) into memory."
18654 READ S$(*)
18660 Helpscreen(S$(*),21,1)
18666 DATA "General information about Raw-DataFiles:$To use raw-data from a datafile, you must first have sto
      red the data using the /PF option from the"
18672 DATA "VISICALC program, using the VISICALC 'template' on the PBDAT disk.  This 'template' will give you
       the correct format and column- headings for"
18678 DATA "your raw-data files.  When you store the raw-data file using the /PF option, make sure that the c
      ursor is at the upper-right, and that you"
18684 DATA "specify a lower-right corner that competely includes the raw-data spreadsheet.$The top row of the
       raw-data spreadsheet can be used for a fairly"
18690 DATA "complete title (up to 80 characters) for this file, which will appear on the CRT when you access
      the file from within PBDAT.$"
18696 DATA "The raw-data spreadsheet can contain various specifiers in the SAMPLE NAME columns (A and B) whic
      h can tell PBDAT how you want the data reduced.$"
18702 DATA "For example, if the characters  *205* appear either in a sample name, or in columns A and B with
      out any sample-data, then samples in that"
18708 DATA "row and all following rows (or until canceled by another specifier) will be reduced assuming the
      use of a Pb-205/U/Th-230 spike.$"
18714 DATA"Other specifiers are:$*208*  Samples assumed spiked with Pb-208.$*235*  Samples assumed spiked w
      ith U-235.$*233*  Samples assumed spiked"
18720 DATA" with a mixed U-233/U-236 spike.$*TU*    Samples assumed to be total-spiked for U (and Th).$*PU*
       Samples assumed to be spiked with U"
18726 DATA"(and Th) in the same aliquot as the Pb-spiked aliquot.$*SAMSPK*  Data for U-233/236 spiked samples
       will be in the form of sample-233/spike-238 "
18732 DATA "ratios rather than the raw 233/236 & 233/238 ratios.$*368*  Data for U-233/236 spiked samples wil
      l be in the form of raw 233/236 and 233/238"
18738 DATA"ratios.$*L*     Use a specific LABDATA file, where the name of the LABDATA file follows the specif
      ier."
18744 REDIM S$(13)
18750 READ S$(*)
```

```
18756  Helpscreen(S$(*),12,0)
18762 SUBEND
18768  !
18774  !
18780 Clear:SUB Clear   ! Clear CRT
18786  OUTPUT KBD;CHR$(255)&CHR$(75);
18792 SUBEND
18798 !
18804 !
18810 Form:SUB Form(Last_response$(*),Firstchoice,OPTIONAL Helpsub)
18816  OPTION BASE 1
18822  COM /Form/ Prompt$(*),Response$(*),Use(*),Range(*),Nval(*),Escape
18828 ! General-purpose Form fill-out screen.
18834 !
18840 ! K.R. Ludwig, U.S. Geological Survey, July 30, 1985.
18846 !
18852 ! The PROMPT$ array contains the prompts or labels of the parameters.
18858 ! The RESPONSE$ array as passed to the subprogram contains the default
18864 !   responses, and returns any changed responses.
18870 ! The USE array determines whether a given parameter can be accessed by
18876 !   the parameter cursor and changed (0 if forbidden, 1 if OK).
18882 ! The RANGE array indicates the minimum & maximum permissible values for a
18888 !   parameter, such as 1,16  (other possible restrictions are: 0,0 for any
18894 !   range, -1,-1 for any string, -2,-2 for Y(es)/N(o)).
18900 ! Parameters whose values must be entered by the user before submitting
18906 !   the FORM are indicated with a passed RESPONSE$ of a double question-
18912 !   mark (??).
18918 ! PROMPT$ and RESPONSE$ must be dimensioned for string-lengths of no more
18924 !   than 36 and from 37 to 40, respectively.
18930 ! No more than 17 choices can fit on the screen at one time.
18936 ! The cursor is controlled by either the KNOB, by CONTINUE (increment
18942 !   parameter)/CONTROL-CONTINUE (decrement parameter), the UP-ARROW and
18948 !   DOWN-ARROW keys, or the SHIFT-UP-ARROW (first parameter) and
18954 !   SHIFT-DOWN-ARROW (last parameter) keys.
18960 !
18966 ! The PROMPT$, RESPONSE$, USE, RANGE and NVAL arrays must be DIMensioned
18972 !   or REDIMensioned to the maximum number of parameters to appear on
18978 !   the CRT (no more than 17).
18984 ! FIRSTCHOICE defines the parameter that the cursor will be on when the
18990 !   FORM is entered.  ESCAPE becomes 1 if the user escapes from the FORM
18996 !   with the ESCAPE softkey.
19002 ! The NVAL array contains any numeric responses.
19008 !
19014 !
19020  DIM A$[40],B$[38],C$[50],Cn$[1],Ci$[1],O$[3],Response_in$(17)[40]
19026  MAT Nval= (0)
19032  Cn$=CHR$(128)  ! Normal
19038  Ci$=CHR$(129)  ! Inverse-video
19044  Escape=0
19050  B$=RPT$(" ",38)
19056  C$=RPT$(" ",50)
19062  O$=Ci$&" "&Cn$
19068  Nchoices=SIZE(Prompt$,1)    ! Number of parameters passed to FORM.
19074  Header=INT((17-Nchoices)/2) ! Number of blank lines at top of screen.
19080  FOR I=1 TO Nchoices         ! Find max. prompt-string length.
19086    IF LEN(Prompt$(I)))>Promptlength THEN Promptlength=LEN(Prompt$(I))
19092  NEXT I
19098  IF Promptlength<15 THEN Promptlength=15 ! Avoid few dashes in cursor
19104  IF Promptlength<30 THEN Promptlength=Promptlength+3
19110  Ptab=INT((36-Promptlength)/2+1) ! TAB position of start of prompt string.
19116  Rtab=INT(Ptab+5+Promptlength)   !  "    "    "    "      response string.
19122  OFF KEY
19128  FOR I=1 TO Nchoices    ! Fill NVAL array with default numeric responses.
19134    ON ERROR GOTO 19146
```

```
19140    Nval(I)=VAL(Response$(I))
19146    OFF ERROR
19152  NEXT I
19158  !
19164 Begin:CONTROL 1,4;0            ! HOME key
19170  CONTROL KBD;1                 ! Put CAPS LOCK on
19176  Capslock=1
19182  Clear
19188  FOR I=1 TO Nchoices
19194    PRINT TABXY(Ptab,I+Header);Prompt$(I);TAB(Rtab);Response$(I)
19200  NEXT I
19206  PRINT TABXY(1,18);"Use  ARROWS, (CTRL) CONTINUE  or KNOB to move cursor";
19212  IF NPAR(3 THEN PRINT " to different parameters."
19218  IF NOT Helped THEN
19224    P=Firstchoice
19230    WHILE Use(P)=0
19236      P=P+1
19242    END WHILE
19248    Np=P                ! "new" parameter#
19254  END IF
19260  Helped=1
19266  !
19272 Change_params:PRINT TABXY(Rtab-1,P+Header);B$! Blank out response area
19278  ! Restore display-format for previous parameter
19284  PRINT TABXY(Ptab,P+Header);Prompt$(P);TAB(Rtab);Response$(P)[1,38]
19290  L1=LEN(Prompt$(Np)) ! Add pointer-dashes.
19296  PRINT TABXY(1+Ptab+L1,Np+Header);RPT$("-",1+Promptlength-L1)&">"
19302 Inverse:PRINT TABXY(Rtab-1,Np+Header);FNH$(Response$(Np)[1,37])
19308 ! Print response to be changed in inverse video
19314 !
19320  DISP FNH$("ENTER")&" a new value,  press "&FNH$("EXECUTE")&"  when all parameters are defined."
19326  ON KEY 9 LABEL "    ESCAPE" GOTO 19326
19332  IF NPAR=3 THEN ON KEY 4 LABEL "    HELP" GOTO 19332
19338  !
19344 Begin response:J=0             ! Counter for position in response-string
19350  A$=Response$(Np)
19356  !
19362 Get keystroke:ON KBD ALL GOTO Whichkey
19368  ON KNOB .05 GOTO 19386
19374  GOTO 19374
19380    !
19386  IF KNOBX)0 THEN
19392    ON KNOB .1 GOSUB Retrn    ! Dummy
19398    GOTO Downcursor
19404  ELSE
19410    ON KNOB .1 GOSUB Retrn    ! Dummy
19416    GOTO Upcursor
19422  END IF
19428    !
19434 Whichkey:K=FNGet key           ! Determine code of the key that was pressed
19440  ON KBD ALL GOSUB Retrn        ! Dummy
19446!
19452  SELECT K
19458  CASE -199                     ! k9 key pressed
19464    Escape=1
19470    Clear
19476    GOTO Formexit
19482  CASE -187                     ! ENTER key pressed
19488    Execute_pressed=0
19494    GOTO Enter_response
19500  CASE -168                     ! EXECUTE key pressed
19506    Execute_pressed=1
19512    GOTO Enter_response
19518  CASE -187,-170                ! CONTINUE or DOWN-ARROW key pressed
```

```
19524     GOTO Downcursor
19530   CASE 11,-162,0              ! CONTROL-CONTINUE or UP-ARROW keys pressed
19536     GOTO Upcursor
19542   CASE -169                   ! SHIFT-UP-ARROW key pressed
19548     P=Np
19554     Np=1
19560     WHILE Use(Np)=0
19566       Np=1+Np
19572     END WHILE
19578     GOTO Change_params
19584   CASE -172                   ! SHIFT-DOWN-ARROW key pressed
19590     P=Np
19596     Np=Nchoices
19602     WHILE Use(Np)=0
19608       Np=Np-1
19614     END WHILE
19620     GOTO Change_params
19626   CASE -213                   ! INS CHR key pressed
19632     IF J<39 THEN
19638       A$[J+2]=A$[J+1,49]
19644       A$[J+1,J+1]=" "
19650       PRINT TABXY(Rtab+J,Np+Header);Ci$&A$[J+1,J+1]&Cn$&A$[J+2,36]
19656     END IF
19662   CASE -211                   ! DEL CHR key pressed
19668     IF J>-1 AND J<LEN(TRIM$(A$)) THEN
19674       A$[J+1]=A$[J+2]&" "
19680       PRINT TABXY(Rtab+J,Np+Header);Ci$&A$[J+1,J+1]&Cn$&A$[J+2,36]
19686     END IF
19692   CASE -196,-194,-190  ! Right-arrow, Left-arrow, or BACKSPACE key pressed:
19698     !  Move the cursor for the current position in the response string.
19704     IF J=-1 THEN Begin_response
19710     J=J+(K=-194)-(K=-196 OR K=-190)
19716     IF J<0 THEN J=0
19722     IF J>37 THEN J=37
19723     ON ERROR GOTO Begin_response
19728     PRINT TABXY(Rtab,Np+Header);A$[1,J]&Ci$&A$[J+1,J+1]&Cn$&A$[J+2,LEN(A$)]
19729     OFF ERROR
19734   CASE -221       ! CLR LN key pressed- clear the response area
19740     PRINT TABXY(Rtab-3,Np+Header);"-) "&CHR$(127)&REPT$(" ",38)
19746     GOTO Begin_response
19752   CASE -193                   ! RECALL key pressed - invokes last responses
19758     A=0
19764     FOR I=1 TO Nchoices
19770       A=A+(Last_response$(I)<>"")
19776     NEXT I
19782     IF A THEN
19788       ON ERROR GOTO 19812
19794       FOR I=Np TO Nchoices
19800         Response$(I)=Last_response$(I)
19806         Nval(I)=VAL(Response$(I))
19812       NEXT I
19818       OFF ERROR
19824       Firstchoice=Np
19830       GOTO Begin
19836     ELSE
19842       Clunk
19848       GOTO Get_keystroke
19854     END IF
19860   CASE -176       ! PAUSE key
19866     PAUSE
19872   CASE -171       ! CAPS LOCK key pressed
19878     Capslock=NOT Capslock
19884     CONTROL KBD,3;Capslock
19890     BEEP 300+300*Capslock,.1
```

```
19896  CASE -204,8,15,31   ! k4, CTL-H, CTL-/, CTL-?:  Invoke a HELP subprogram.
19902    IF NPAR=3 THEN
19908      SELECT Helpsub
19914      CASE 2
19920        Help2(Np)
19926      CASE 3
19932        Help3(Np)
19938      CASE 4
19944        Help4(Np)
19950      CASE 5
19956        Help5(Np)
19962      CASE 6
19968        Help6(Np)
19974      CASE 7
19980        Help7(Np)
19986      CASE 8
19992        Help8(Np)
19998      CASE 9
20004        Help9
20010      CASE 10
20016        Help10
20022      CASE 11
20028        Help11
20034      CASE 12
20040        Help12
20046      CASE ELSE
20052        GOTO Badkey
20058      END SELECT
20064      Helped=1
20070      P=Np
20076      GOTO Begin     ! Re-construct the FORM as left before HELP.
20082    ELSE
20088      GOTO Badkey
20094    END IF
20100    !
20106  CASE (32,)126       ! Invalid key - don't do anything
20112    GOTO Badkey
20118  CASE ELSE
20124      !
20130    J=J+1             ! Increment string-position
20136    IF J)40 THEN J=40
20142    A$[J,J]=CHR$(K)   ! Define this character of the response-string
20148    IF J=1 THEN
20154      PRINT TABXY(Rtab-3,Np+Header);"-)"&RPT$(" ",40)  ! Clear response area
20160      A$=CHR$(K)&C$[1,39]
20166    END IF
20172    ! Print the new character in the response area, followed by a cursor
20178    IF J(38 THEN PRINT TABXY(Rtab-1+J,Np+Header);A$[J,J]&C1$&A$[J+1,J+1]&Cn$
20184  END SELECT
20190  GOTO Get_keystroke
20196!
20202 Downcursor:P=Np               ! Move parameter-cursor down until on an
20208  REPEAT                       !  allowed parameter.
20214    Np=Np+1
20220    IF Np)Nchoices THEN Np=1   ! Wraparound to parameter #1.
20226  UNTIL Use(Np)
20232  GOTO Change_params
20238!
20244 Upcursor:P=Np                 ! Move parameter-cursor up until on an
20250  REPEAT                       !  allowed parameter.
20256    Np=Np-1
20262    IF Np(1 THEN Np=Nchoices   ! Wraparound to last parameter.
20268  UNTIL Use(Np)
20274  GOTO Change_params
```

```
20280!
20286 Badkey:Clunk
20292  GOTO Get_keystroke
20298!
20304 Enter_response:Response$(Np)=TRIM$(A$)
20310  P=Np
20316  Nval(P)=0
20322  IF Response$(P)()"?" THEN
20328    Numeric=0
20334    ON ERROR GOTO 20378
20340    Value=VAL(Response$(P))         ! If no error, string is a valid number
20346    Nval(P)=Value
20352    OFF ERROR
20358  END IF
20364  Numeric=1
20370  OFF ERROR
20376  R1=Range(P,1)                     ! Minimum allowable numeric response
20382  R2=Range(P,2)                     ! Maximum      "       "       "
20388  IF R1=-1 AND R2=-1 THEN Resp_processed      ! String response OK
20394  IF R1=-2 AND R2=-2 THEN                     ! Must be Y(es)/N(o)
20400    R$=UPC$(Response$(P)[1,1])
20406    IF R$="Y" OR R$="N" THEN Resp_processed
20412    DISP FNH$("YOU MUST ENTER")&FNB1$("Y")&FNH$("OR")&FNB1$("N")&FNH$("FOR THIS PARAMETER")
20418    GOTO Clunkout
20424  END IF
20430  IF NOT Numeric THEN
20436    DISP FNH$("YOU MUST ENTER A NUMERIC RESPONSE TO THIS PARAMETER")
20442    GOTO Clunkout
20448  END IF
20454  IF R1()0 OR R2()0 THEN
20460    IF Value(R1 OR Value)R2 THEN
20466      DISP FNH$(VAL$(Value)&" IS NOT WITHIN THE ACCEPTABLE RANGE ("&VAL$(R1)&" - "&VAL$(R2)&") "&"FOR THI
     S PARAMETER")
20472      GOTO Clunkout
20478    END IF
20484  END IF
20490!
20496 Resp_processed:IF Execute_pressed THEN Done
20502!
20508  BEEP 660,.06
20514  GOTO Downcursor
20520!
20526 Done:FOR I=1 TO Nchoices
20532    ! Must enter a response for parameters with default responses of ??.
20538    IF Response$(I)[1,2]="??" THEN Incomplete
20544  NEXT I
20550  Clear
20556  SUBEXIT
20562!
20568 Incomplete:! Check for undefined but essential parameters
20574  DISP FNH$("SORRY- YOU MUST ENTER A VALUE FOR EVERY")&FNB1$("??")&FNH$("PARAMETER.")
20580  Clunk
20586  WAIT 2.5
20592  Np=I
20598  GOTO Change_params
20604!
20610 Retrn:RETURN   ! Dummy RETURN
20616!
20622 Clunkout:Clunk ! Response to an invalid entry
20628  WAIT 2
20634  Response$(P)="?? "&Cn$&RPT$(" ",30)
20640  GOTO Inverse
20646!
20652 Fxnexit:SUBEND ! ----------------------------------------------------
```

```
20658 Clonk:SUB Clonk  ! Clonky sound to indicate error
20664! BEEP 250,.1     ! for quiet environments
20670! BEEP 100,.2
20676  FOR J=0 TO 2000 STEP 200
20682    FOR I=1 TO 1  ! Better for a noisy environment
20688      BEEP 3500-J,.001
20694    NEXT I
20700  NEXT J
20706 SUBEND
20712 Help9:SUB Help9   ! HELP screen for 233/236-spiked U ratios FORM
20718  OPTION BASE 1    !  without SAM/SPK.
20724  DIM S$(4)[160]
20730  DATA "$$$$Enter the appropriate ratios for the U(Th)-spiked aliquot, uncorrected for any mass-discrim
       ination.  If your data comes from a"
20736  DATA "mass-spectrometer running under ANALYST, you should be using the format that asks for the sampl
       e-238/spike-233 ratio from ANALYST's"
20742  DATA "double-spike data-reduction option, not this format (SHIFT-k7 from the initial PBDAT screen to ch
       ange)."
20748  DATA "$Enter the U(Th) blanks, in nanograms, that correspond to the U(Th)-spiked aliquot."
20754 !
20760  READ S$(*)
20766  Helpscreen(S$(*),0,0)
20772 SUBEND
20782 !
20792 !
20802 Rowcol:SUB Rowcol(N,Row,Col)
20813  Col=4+19*(N-1)
20814  REPEAT
20815    IF Col>61 THEN Col=Col-76
20816  UNTIL Col<62
20817  Row=4+2*INT((N-1)/4)
20818 SUBEND
```